A FINANCIAL COMPARISON OF A COAL WATER SLURRY PIPELINE TO THE RAIL SYSTEM FOR TRANSPORTING THERMAL COAL FROM ALBERTA TO THE WEST COAST OF BRITISH COLUMBIA

A Report Prepared for
The Government of Alberta by

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This report describes the methodology and results of a preliminary investigation of the relative land transportation costs of moving thermal coal from Alberta to the Canadian west coast by coal water slurry pipeline. It has been prepared as a working document to be used as a basis for discussion. The description and interpretation of the findings contained herein are not necessarily coincident with the policy of the Government of Alberta.

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EXECUTIVE SUMMARY

1. SCOPE AND OBJECTIVES

In 1981, the Government of Alberta commissioned Fluor Canada Ltd. to investigate the technical feasibility and estimate the cost of transporting 10.2 and 18.2 million tonnes of thermal coal from Alberta to a Canadian west coast port site by coal water slurry pipeline. It was determined that a coal water slurry pipeline designed to transport these volumes of coal is technically feasible.

The objective of this report is to examine and compare the land transportation costs of this pipeline with those of a rail unit train operation designed to transport the same volumes of coal over a similar route. A financial analysis of the rail and pipeline alternatives was used as a basis for comparison of the two modes.

This report is not an assessment of the pipeline's economic feasibility. The economic feasibility of this project depends on a number of factors outside the scope of this analysis, such as the availability of coal supplies, coal quality, service considerations related to slurry transportation, ocean transport, coal marketing, and coal burning technology. This study investigates the relative land transportation costs of the two modes in isolation of the factors mentioned above.

2. SLURRY PIPELINE AND RAIL SYSTEMS

To facilitate modal comparison, the rail and slurry pipeline systems were both assumed to transport 10.2 and 18.2 million tonnes of thermal coal originating from five mine sites near Coalspur, Alberta. These shipments were assumed to begin in 1990 and to continue for 35 years. The coal transported was assumed to be new traffic over and above the volumes currently forecast to move on the rail system in the 1990's.

The proposed slurry pipeline system would begin at Coalspur, Alberta and traverse 1,066 kilometres (631 miles) to the Port of Kitimat in British Columbia. The system was engineered to transport a slurry mixture of 49 per cent water and 51 per cent coal by weight. It has four major components: the water gathering system, the slurry preparation plants, the main pipeline and pump stations, and the slurry terminal. A detailed description of the pipeline system and its associated costs is provided in The Coal Slurry Pipeline Feasibility Study 1981 by Fluor Canada Ltd.

A rail system was designed and costed which would transport the same volumes of coal over a route similar to that of the slurry pipeline system. Two routing possibilities were considered. One assumed a new section of track would be built to more directly link Coalspur with the Canadian National Railways mainline. The distance from Coalspur to the Port of Prince Rupert would be 1,337 kilometres (831 miles). The other route followed existing rail lines from Coalspur to Prince Rupert, a distance of 1,390 kilometres (864 miles). The rail system was assumed to terminate at Prince Rupert instead of at Kitimat because Prince Rupert is committed to having a great deal of infrastructure in place by 1990, when the Coalspur mines would begin to produce coal. The three major components of the rail system are: the coal preparation and loading facilities at the mine site, the railway line and rolling stock, and the coal terminal at the port site. The entire system was designed to accommodate a unit train operation.

It should be noted that the pipeline and railway will deliver essentially a different product to the west coast. The pipeline will deliver coal in a slurry form (45 per cent moisture) and the railway will deliver dry bulk coal (10 to 15 per cent moisture). For the purpose of this study, the pipeline slurry terminal case was used as a basis for comparison with rail mode. Given that current coal burning technology requires drier coal than that delivered by the pipeline slurry terminal scenario, the coal in this case will have to

undergo drying at some point before burning. The determination of the precise amount of dewatering which would be required for the coal water slurry to be commercially burnable is a technical question beyond the scope of this analysis, as is the determination of the marketability of such a product. In addition, the amount of drying which would be done at the west coast port site, if any, is at the discretion of the coal buyer.

3. METHODOLOGY

The cost competitiveness of each mode was evaluated using a financial model yielding a series of nominal minimum tariffs which would recover all costs, including a market rate of return for the investors, over the 35 year life of each project. The analysis assumed both modes would operate in an environment with no tariff regulation and no new government involvement. The mode able to cover all its costs and offer the lowest tariff was judged to be the most cost competitive coal transportation system.

In addition to the base analysis, a number of sensitivity tests were conducted to determine if the relative cost competitiveness of the modes would be affected by changing the underlying assumptions made in the analysis. These included assumptions concerning the amount of slurry dewatering, the effect of tariff regulation, changes in the rate of inflation and the cost of capital and changes to the capital structure as well as changes in the rail operating assumptions and the achievement of specific throughputs.

4. CONCLUSIONS

At 10.2 million tonnes of throughput, the slurry pipeline tariffs were calculated to be about 8 per cent lower than the rail tariffs. When the annual coal throughput was raised to 18.2 million tonnes, the slurry pipeline tariffs were about 18 per cent lower than the rail alternative.

These minimum tariff estimates indicate that the slurry pipeline is a potentially cost competitive alternative to the rail unit train operation. However, given the wide confidence intervals on the cost estimates it cannot be stated which is the least cost mode.

An important factor which could affect the relative cost competitiveness of the slurry pipeline would be the imposition of tariff regulation similar to that currently applied to most inter-provincial oil and gas pipelines in Canada. This type of tariff regulation would make it impossible for the pipeline to compete with the railway during the early years of operation.

The amount of slurry dewatering required would also have a significant impact on the cost competitiveness of the pipeline. If coal buyers specify that a substantial amount of dewatering is required before the coal is burned, the cost competitiveness of the slurry pipeline will be reduced.

The cost competitiveness of the pipeline was found to be relatively sensitive to the proportion of debt assumed in its capital structure. This result highlights the importance of operating, sales and or financial guarantees which would allow potential pipeline investors to increase their leverage in the project.

A drop in the forecasted rate of inflation in conjunction with a drop in the debt and equity enhanced the cost competitiveness of the pipeline. As this analysis was conducted in a period of relatively high inflation and interest rates, a return to their more historical levels will enhance the cost competitiveness of the pipeline.

The cost competitiveness of the pipeline was found to be reduced if the design throughput levels were not achieved. The rail option was found to be considerably more flexible with respect to volume fluctuations.

Finally, the pipeline was found to exhibit economies of scale to a greater degree than the rail unit train operation. Thus the pipeline's cost competitiveness increases as the design throughput is increased.

5. RECOMMENDATIONS

In this analysis, the rail and slurry pipeline tariffs were too close to clearly establish which mode would be the most cost competitive coal transportation system. Putting this result in perspective, it must be remembered that compared with rail technology, slurry pipeline technology is relatively new. As a result, there is a greater opportunity for cost reducing innovations affecting pipeline capital and operating costs. In addition, this analysis was conducted during a period of high interest rates and economic uncertainty. These conditions have now changed significantly. It is therefore recommended that technical developments and financial conditions affecting the pipeline be surveyed on a regular basis, and that the impact of these changes on the competitiveness of the pipeline be assessed.

This report concentrated on the cost competitiveness of a slurry pipeline with a railway unit train operation. Given the close proximity of the costs of both modes, it is recommended that a comprehensive analysis be undertaken to assess the economic feasibility of the slurry pipeline project. This investigation should establish the cost per B.T.U. of producing, transporting, and burning coal in various combinations of slurry and dry bulk form. These results could then be compared to the cost per B.T.U. of dry coal shipped by a conventional railway system. This in depth study would most effectively be conducted by an industry or group of industries interested in expanding coal markets.

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CHAPTER 1 INTRODUCTION

1. EXPORT OPPORTUNITY FOR THERMAL COAL

During the last decade, rising energy prices and heightened international concern about the security of energy supplies have resulted in renewed interest in the energy potential of thermal coal. Many countries have increased their coal imports, and the world coal trade has expanded considerably. This trend is expected to continue during the next decade. Japanese imports of thermal coal, for example, are forecast to increase from 11.4 million tonnes in 1981 to between 38 and 60 million tonnes by 1990.[1] The continuing expansion of Japanese and other Pacific Rim markets for thermal coal represents a significant export opportunity for Western Canada's thermal coal industry.

If the Western Canadian coal industry is to take advantage of this opportunity, it will require access to an efficient and economical coal transportation system. Important coalfields are located in Western Alberta 800 to 1000 kilometres from Canadian west coast coal terminals at Vancouver and Prince Rupert. Inland transportation costs currently comprise up to one third of the price of coal sold F.O.B. from these ports. At the present time, export coal moving to the west coast is captive to the rail system. In the period from 1970 to 1980, Alberta coal shippers have been faced with a rail rate increase of over 400 per cent. It has become increasingly obvious that further rate increases of this magnitude could impair the coal industry's ability to remain competitive suppliers and their ability to increase thermal coal exports beyond current levels. In addition, the railways are reaching capacity on their westbound lines and massive capital expenditures are planned to meet future traffic forecasts. The cost of this expansion program must be recovered from shippers through the rates charged. In these circumstances, it seems prudent to investigate the possibility

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[1] Canadian Embassy, Tokyo, "Revised Interim Report on the Japanese Market for Imported Thermal Coal", 1982, page 8.

of utilizing a new transportation system such as a coal slurry pipeline, which may, by providing a lower cost mode of transport, enable the Province's coal companies to expand their market. For the purpose of this analysis, the thermal coal handled by either system was assumed to be new traffic. That is, these volumes of coal are over and above the volumes currently forecast to move on the rail system in the 1990's.

2. OBJECTIVE OF THIS STUDY

In 1981, the Government of Alberta commissioned Fluor Canada Ltd. to investigate the technical feasibility and the cost of transporting 10.2 and 18.2 million tonnes of thermal coal to a Canadian west coast port site by coal water slurry pipeline. The consultants completed their study at the end of 1981. Their major finding was it would be technically feasible to transport these volumes of coal from coal mines near Coalspur, Alberta by slurry pipeline to a port site at Kitimat in British Columbia. Their report also contains preliminary engineering design and cost estimates for the slurry pipeline system. The remainder of this report represents an attempt by the Government of Alberta to determine if this proposed Coalspur to Kitimat slurry pipeline could transport coal to the west coast at lower cost than the rail system.

This report is not an assessment of the economic feasilibility of constructing a coal slurry pipeline between Coalspur and Kitimat. The economic feasibility of such a project would depend on a number of factors outside the scope of this analysis such as the availability of coal supplies, coal quality, service considerations related to slurry transportation, ocean transport, coal marketing, and coal burning technology. Without having investigated the entire coal chain including coal production, transportation and utilization, it is not possible to comment on the economic feasibility of coal slurry transportation. This study evaluates the costs associated with the rail and slurry pipeline systems, and attempts to determine which mode would be the most cost competitive for coal transportation.

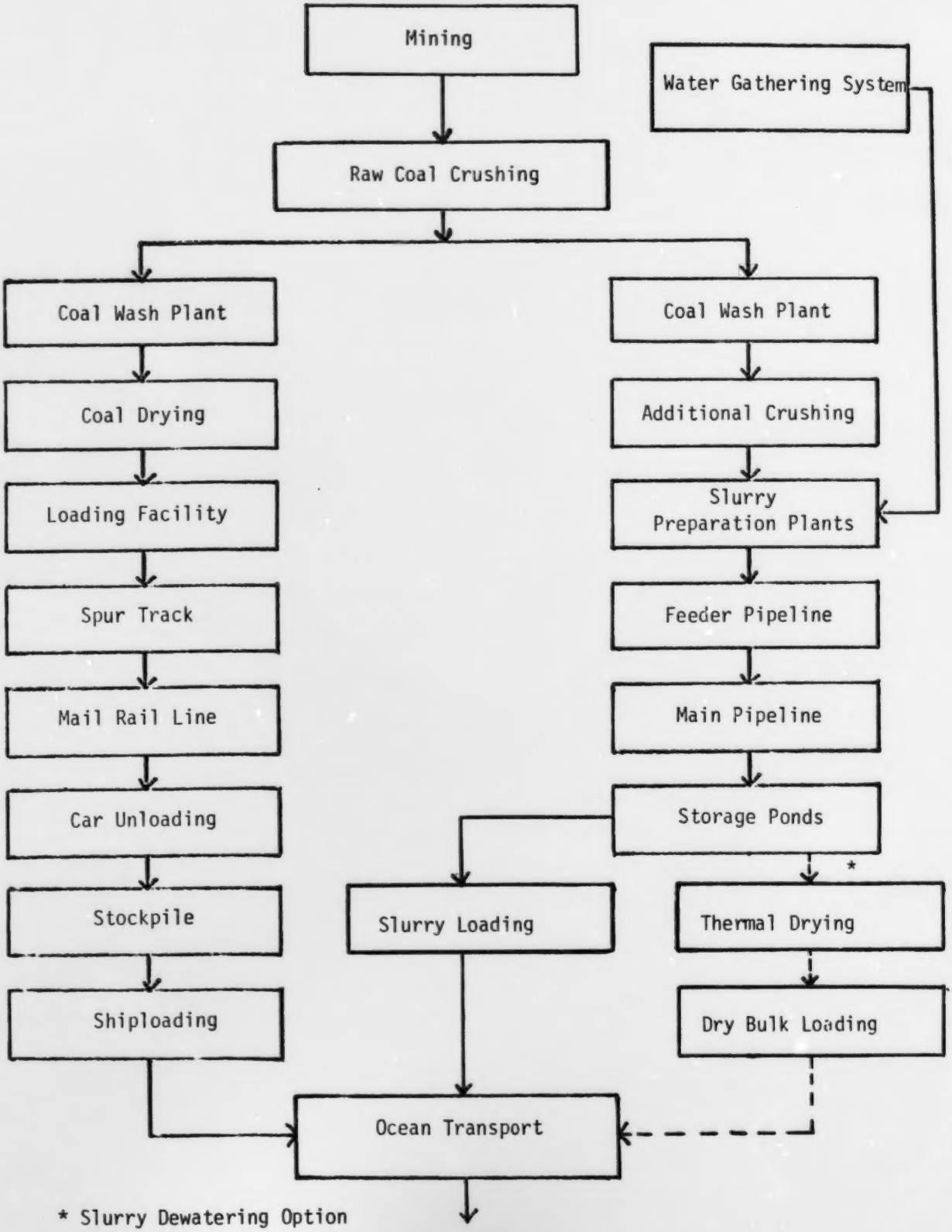
3. RAIL AND SLURRY PIPELINE SYSTEMS

The following analysis evaluates the cost of moving thermal coal by two very different transportation systems. As shown in Figure 1, both systems begin with coal mining and raw coal crushing. After this, however, the systems diverge. The rail system includes a dry bulk handling system for coal preparation and loading, rail transportation to the port, and a conventional rail based coal terminal with dry bulk storage and shiploading equipment. The slurry pipeline system includes a water gathering system, slurry preparation plants, pipeline transportation to the port, and a slurry terminal with storage ponds and slurry shiploading equipment. Both systems could be used to transport coal to the west coast, but each system would deliver the coal in a different state. The rail system would deliver dry bulk coal, while the pipeline system would deliver coal in slurry form.

At the port, the coal would be loaded for ocean transport in slurry form or dewatered to a specific level to meet buyer needs. With the slurry pipeline system, the coal buyer is able to decide on the optimal level of dewatering. In making this decision the buyer must trade-off the cost of drying the coal with the gain in burning efficiency (b.t.u. value per tonne) of progressively drier coal. For purposes of conducting this analysis a two stage approach was used. The basis of the analysis concentrates on the coal in slurry form. Subsequently, the extreme case of drying the coal to 90% dry matter was analyzed to determine the sensitivity of the pipeline's cost competitiveness to drying costs.

FIGURE 1:

COMPARISON OF RAIL AND SLURRY PIPELINE SYSTEMS



* Slurry Dewatering Option

CHAPTER 2 METHODOLOGY

1. EVALUATING COST COMPETITIVENESS

Considerable attention was given to the development of a methodology which would meaningfully evaluate the cost competitiveness of a coal slurry pipeline versus a rail unit train operation.

The basic premise used in the analysis was that the least cost mode would have the competitive advantage. In order to identify the least cost mode, the methodology had to satisfy the following conditions:

(1) It had to facilitate the comparison of rail and slurry pipeline systems, and to evaluate both modes in a consistent manner.

(2) It had to be able to evaluate both modes as private ventures built and operated in the current business environment without any new government assistance. More specifically, it had to incorporate the realities of the marketplace with respect to likely financing arrangements, the effects of taxation, and the timing of revenues and expenditures.

(3) It had to be suitable for evaluating rail and slurry pipeline systems operating under competitive market conditions with unregulated tariff structures.

Since both modes would have to make major capital expenditures to accommodate the traffic, a capital budgeting approach was deemed to be most appropriate.

Using a financial model the minimum tariff each mode would charge in order to generate sufficient revenue to recover the incremental costs associated with the movement was calculated. Thus this method will produce tariffs which approximate those which could be quoted by the modes to handle the specified traffic. The actual rates charged to shippers could be higher, depending on the amount of competition and "what the traffic will bear". However, calculating minimum rate levels is a meaningful way of evaluating different modes, because the mode able to offer the lowest rates and still cover all its costs would have a competitive advantage.

The calculation of the minimum tariff for each mode requires that a number of factors be taken into consideration. These are:

(1) The capital outlays necessary to accommodate the traffic.

(2) Incremental operating costs.

(3) The time value of money.

(4) The method of financing the project including the capital structure and the cost of the capital employed (both debt and equity).

(5) The effect of inflation on capital and operating costs, on financing arrangements, and on the growth of tariffs over time.

(6) Debt repayment schedules.

(7) Tax considerations including capital cost allowance and investment tax credits.

Taking the above factors into consideration the minimum tariffs would cover all the incremental costs associated with the project including interest on debt and a return to equity holders.

2.0 Study Methodology

2.1 Rail and Pipeline Cost Estimates

To calculate minimum rail and slurry pipeline tariffs, it was first necessary to design a rail system which would be as comparable as possible with the slurry pipeline system, and to estimate rail capital and operating costs. The rail and slurry pipeline systems that were analysed in this study are described in Chapters 3 and 4. These Chapters also explain how cost data was generated for each mode.

Chapters 3 and 4 also describe the most likely financing scenarios for the rail and pipeline options. Estimates are also made of the expected cost of debt and equity financing. The financing assumptions used in the analysis reflect market conditions in the middle of 1982 when interest rates were at a peak. Consequently, it was necessary to test the results for their sensitivity to the cost of capital. The results of these tests are included in Chapter 7.

2.2 Inflation

Inflation was forecast from the present to the year 2024, when both the rail and slurry pipeline projects were assumed to end. Separate forecasts were used for capital, operating, and financing costs. The Investment in Pipelines, Electricity, and Mining deflator produced by Data Resources Inc. was used to convert rail and slurry pipeline capital costs into current dollars. Since all rail and slurry pipeline capital investment would occur by 1992, it was only necessary to forecast inflation for capital costs until that year. The Service Receipts,

Shipping and Freight deflator also produced by Data Resources Inc. was used to convert rail and slurry pipeline annual operating costs into current dollars. As shown in Figure 2, this deflator stabilizes at an annual rate of 8 per cent after 1996. It was assumed to continue at this rate until 2024. With respect to financing, inflation is one of the determinants of debt and equity rates. In the analysis, the interest rate on debt was allowed to vary with the forecast rate of inflation during the construction period and the operating life of the slurry pipeline. The rate of inflation was forecast using the Investment in Pipelines, Electricity and Mining deflator until the end of 1989, and then using the Gross National Product deflator until 2024.

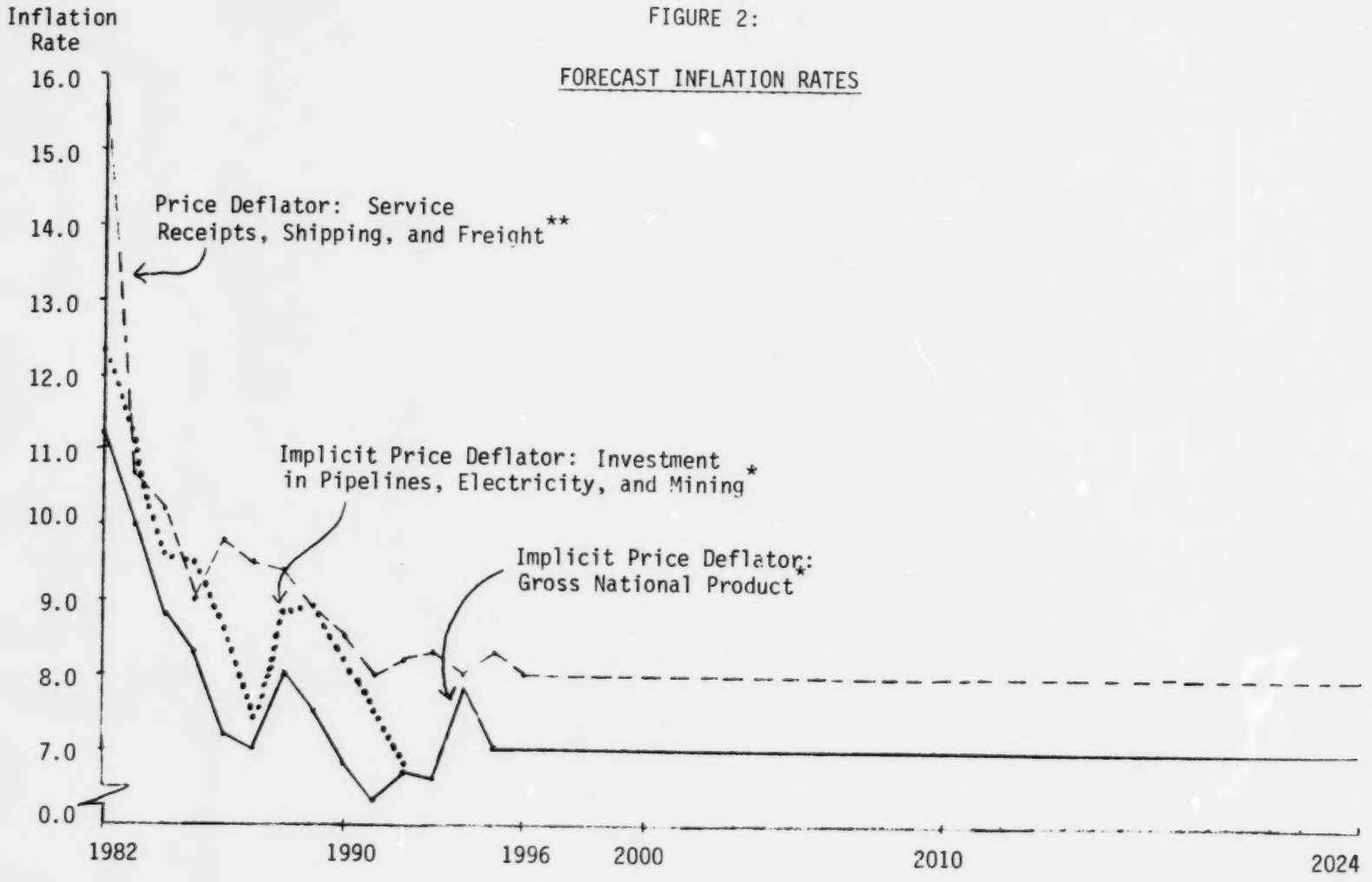
2.3 The Tariff Growth Pattern

The methodology used in this study calculates a stream of tariffs over the life of the project which, when discounted by the weighted average cost of capital, equals the present value of the cash outlays over the life of the project. There is an infinite number of tariff schedules which could have met this criteria. Consequently, it was necessary to identify a reasonable tariff growth pattern. For the purposes of this study, it was decided that unit transportation charges for each mode should be the same each year when expressed in constant 1990 dollars, and rise year by year at the nominal inflation rate when expressed in nominal dollars. Since nominal tariffs for each mode were assumed to grow at the same rate, their relative competitiveness will not change over the life of the project. Thus only the tariffs for 1990 need be compared to judge which mode is most competitive.

From a practical perspective, setting the tariff growth rates at the expected rate of inflation is reasonable. First it must be remembered that the traffic is being offered to either the railway or to the pipeline. Once the decision is made as to which mode to use there is

FIGURE 2:

FORECAST INFLATION RATES



Source: Data Resources Inc.

Footnotes:

*January 31, 1982 Long term forcast.

**Canadian Review: Spring, 1982.

no longer direct competition between the modes. If the pipeline is chosen, the coal would most likely be supplied through long term contracts. These contracts could reasonably be expected to contain annual tariff increases tied to the rate of inflation. However, if the railway is chosen the tariff growth scenario is less certain. The railways tend to avoid long term contracts. In addition, should the real economic value of the thermal coal change, the railways would be expected to seek a rate increase greater than the rate of inflation. However, since it is very difficult to predict changes in the real value of coal, it is safe to stay with the inflation rate as the expected growth rate.

Other tariff patterns are possible and merit consideration. It may be reasonable, given the cost characteristics of the pipeline, to use a lower growth rate than that for the railway. However, using different tariff patterns for each mode may complicate the analysis.

Another method of cost recovery,the rate base rate of return methodology employed in the regulation of most inter-provincial oil and gas pipelines in Canada, produces a significantly different tariff pattern. [1] If the pipeline were regulated using a rate base rate of return methodology, rates each year would be set equal to average costs. With this method, tariffs are based on the cost of providing the service, as defined by a regulatory agency. The cost of service usually includes operating costs, depreciation, taxes, and a specified rate of return on the capital investment, or rate base. Tariffs calculated by this method start out at very high levels, when the rate base is undepreciated, and decline steadily until the rate base is fully depreciated. After this point, the tariffs vary

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[1] At the time of writing, no inter-provincial commodity pipelines have been built in Canada, and no system has been established to regulate the tariffs of these pipelines. The possible impact of rate base rate of return regulation is discussed in Chapter 6.

directly with operating costs, income, taxes and interest payments.

This approach to setting rates was not used to evaluate the two options because the revenue stream produced does not take into account the time value of money. Consequently, a meaningful comparison between options is not possible. This does not imply that the average cost approach can be ignored. It is important to understand the impact that regulation of tariffs could have on the pipeline's revenue stream and competitive position. Chapter 6 explores this problem in some detail.

3. SENSITIVITY TESTS

Numerous assumptions and estimates had to be made in order to undertake an analysis of this nature and scope. At the end of the study, the most important assumptions and estimates were modified to determine if this would significantly affect the cost competitiveness of each mode. Several economically sensitive areas were identified for the railway and for the slurry pipeline. In these areas significant changes in minimum tariff levels resulted when important assumptions or estimates were modified. The results of the sensitivity tests are described in Chapter 6.

CHAPTER 3 THE SLURRY PIPELINE OPTION

1. THE PIPELINE ROUTE

As shown in Figure 3, the proposed pipeline route would begin at five mine sites located near Coalspur, Alberta, and traverse 1,066 kilometres (631 miles) of mountainous terrain to the Port of Kitimat, in British Columbia. After leaving Coalspur, the pipeline would go northwest to Hinton, and then follow the Trans Mountain Oil Pipeline through Jasper National Park to Mount Robson Provincial Park in British Columbia. From there, the pipeline would parallel the Yellowhead Highway along the Rocky Mountain Trench to a point west of Prince George. Then it would follow the Pacific Northern Gas pipeline to Kitimat via Fraser Lake and Telkwa Pass.[1]

2. THE COAL SLURRY PIPELINE SYSTEM

The slurry pipeline system evaluated in this study was designed to transport 10.2 or 18.2 million tonnes of thermal coal per year to a Canadian west coast slurry terminal for export. The pipeline was engineered to transport a slurry mixture of 49 per cent water and 51 per cent coal by weight. The four major components of the system are the water gathering system, the slurry preparation plants, the main pipeline and pump stations, and the slurry terminal.

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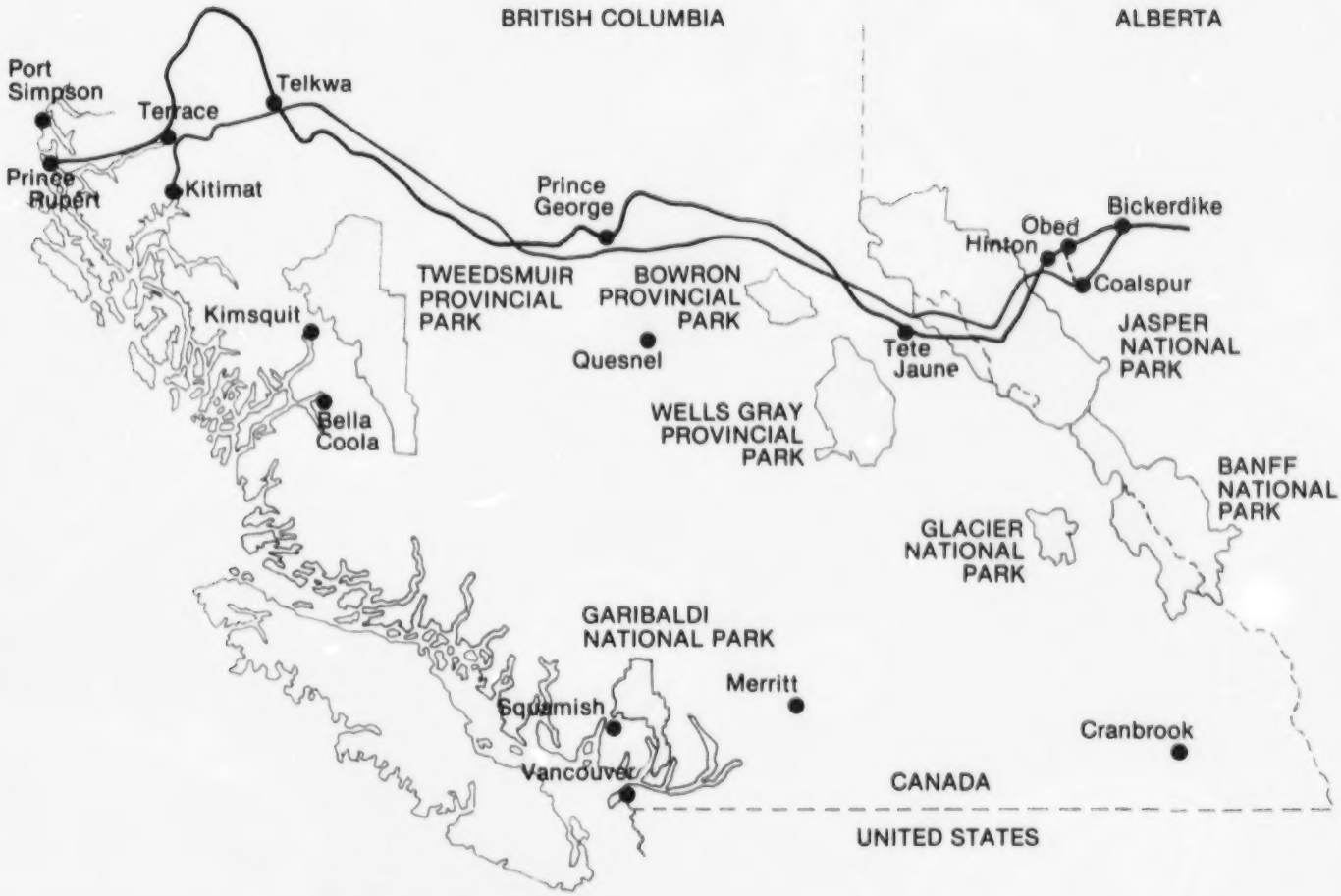
[1] Fluor Canada Ltd., Coal Slurry Pipeline Feasibility Study 1981, November 1981, Contract 775412/703623, Executive Summary, page 1-8.

FIGURE I

Existing Railway and Proposed Pipeline Routes



The water gathering system would transport water from the Athabasca River near Hinton, Alberta by pipeline to each of the five mine site slurry preparation plants.[2]

It was assumed that all the coal would be supplied by five mines located within a 16 kilometre radius of Coalspur, and that each mine would contribute an equal share to the total annual throughput. One slurry preparation plant would be located at each mine site. Slurry would be transported from the five preparation plants to a central gathering plant at Coalspur by feeder pipelines. At Coalspur, the slurry would enter the main pipeline system and begin its journey to Kitimat.

Five different designs were generated for the Kitimat terminal. Each design incorporates different slurry dewatering facilities. The terminal design utilized in this study would allow the slurry to settle in large storage ponds until it reached a concentration of 55 per cent coal by weight. Then it would be pumped on board slurry tanker vessels. The slurry would not pass through a mechanical dewatering process. The four other terminal designs would produce a mechanically dewatered material between 60 and 90 per cent coal by weight. These designs, and the significance of dewatering costs are discussed in Chapter 6.

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[2] A slurry pipeline transporting 10.2 million tonnes of coal per year would require about 0.17 per cent of the measured mean annual flow of the Athabasca River at Hinton, Alberta, or about one per cent of the measured lowest monthly average flow. A pipeline transporting 18.2 million tonnes of coal would require 0.30 per cent of the measured mean annual flow, or 1.85 per cent of the measured lowest monthly average flow. These water withdrawal rates are considered well within acceptable limits, and not significant enough to affect river flow patterns or downstream river water users. For a detailed discussion of water sourcing, refer to the Coal Slurry Pipeline Feasibility Study 1981, page 11-16.

3. CAPITAL AND OPERATING COSTS

Capital and operating costs for the slurry pipeline option are summarized in Table 1. As mentioned earlier, the pipeline cost estimates utilized in this study were developed by Fluor Canada Ltd. as part of a technical report on the feasibility of constructing a slurry pipeline across Northern British Columbia. Detailed cost information is available in their final report. Only summary cost data is reproduced in this chapter.

These cost estimates do not represent the lowest cost slurry pipeline system that could be built to transport coal to the west coast of British Columbia. If the slurry pipeline followed the Trans Mountain pipeline right-of-way to Vancouver instead of going to Kitimat, for example, the route could be shortened by as much as 125 kilometres. This would significantly reduce construction and pipe costs. It would also be cheaper to build and operate a slurry terminal in Vancouver because it is not a remote location. Some savings might also be possible with respect to the system design. Because limited operating experience is currently available, it was difficult to optimize the design of the slurry pipeline system. As more slurry pipelines are built and additional pilot testing is completed, it will be possible to reduce the generous "margin of safety" that was allowed in the design of some system components. There is currently some uncertainty, for example, concerning the burial depth required to prevent the slurry in the pipeline from freezing. If the burial depth could be reduced to less than 1.8 metres, pipe installation costs would be reduced. Fluor Canada Ltd.'s original technical investigation was undertaken to establish the technical feasibility and the approximate cost of constructing a coal slurry pipeline from Alberta to Pacific tidewater across Northern British Columbia. The study was not commissioned to find the shortest route or the most cost-effective method of construction.

TABLE 1:

THE SLURRY PIPELINE OPTION: SUMMARY OF CAPITAL AND OPERATING COSTS AND FINANCING ASSUMPTIONS

(in millions of 1981 dollars)

	Throughput 10.2 Million Tonnes	Throughput 18.2 Million Tonnes
Capital Costs	1,676	2,225
Annual Operating Costs.....	38.1	54.7

Financing Assumptions

Debt:Equity Ratio	Cost of Debt (before tax)	Cost of Equity (after tax)	Debt Repayment Period
75:25	Inflation +8½%	20%	20 years

3.1 Capital Costs

The capital cost estimates summarized in Table 1 include direct and indirect field costs, engineering, procurement, and construction management costs, land and right-of-way costs, and a 25 per cent contingency for any errors, omissions, and system unknowns. The capital costs cover a wide range of activities between the initiation of the project and the beginning of pipeline operations including preliminary design and financial analysis, optimization studies and pilot testing, the securing of regulatory, environmental, and government approvals, and detailed engineering, procurement, and construction.

3.2 Operating Costs

The annual operating cost estimates in Table 1 include all operating and maintenance expenses for the pipeline system outlined earlier in this chapter. The estimates cover maintenance materials and labour; contract labour; operating, security, and engineering labour; consumable supplies; utilities; administration; the services of maintenance subcontractors; and insurance. The water required for slurry pipeline operations was assumed to be available at no cost.

4. TIMING OF EXPENDITURES

The time between project initiation and the beginning of slurry pipeline operations was estimated to be eight years. Assuming the project was initiated in 1982, the pipeline would begin to ship coal in 1990. The pipeline fixed plant was assumed to be completely in place by January 1990. Capital expenditures were assumed to occur between 1983 and 1989 as shown in Table 2. The five mines were assumed to come on stream six months apart, with the first mine commencing production in January 1992. One hundred per cent of the pipeline's operating costs

were assumed to commence in January 1990, as these costs would be relatively insensitive to the volume of coal being transported.

5. FINANCING ASSUMPTIONS

The financing assumptions outlined below are based on a number of industry experts' perceptions of the present financial environment.

Project financing, a relatively new but increasingly common method of financing large investment projects, was found to be the most likely and desirable approach to financing the pipeline.

With project financing, there would be a sharing of risk between the participants in the project, including coal producers, pipeline owners, money lenders and coal buyers. This would require a complex series of negotiations which could result in a variety of possible financial arragements. The assumptions used in this analysis could be considered a conservative financial package in that no attempt was made to speculate on special arrangements, even though they may be fairly likely.

5.1 Project Financing

The basic requirement for any investment to be project financed is that it have an identity and an organization separate from the parent or sponsoring companies. The financing is specific to the project, and thus separate or distinct from any other financing undertaken by the parent companies. Payments on the loan are made out of the project's cash flow and should, therefore, correspond as closely as possible to the income generating ability of the investment. Projects financed in this manner normally have a fairly definite life span, during which all the debt must be repaid.

TABLE 2:

PIPELINE CAPITAL EXPENDITURE SCHEDULE

Year	Per Cent of Capital Expenditure	Capital Expenditures for Each Level of Throughput (in millions of current year dollars) 10.2 Million Tonnes	18.2 Million Tonnes
1983	1%	20.9	27.8
1984	2%	45.8	60.8
1985	12%	301.0	399.7
1986	24%	653.5	867.8
1987	28%	819.2	1,087.7
1988	23%	732.2	972.3
1989	10%	346.9	460.6
1990	—	0.0	0.0
	100%		

One of the major benefits of project financing is it partially shields the participating companies from some of the risk inherent in the project. It does this by limiting the liability of the sponsoring companies to the extent of their equity position in the investment. Project financing is also a means through which numerous companies can cooperate and share both the risks and the benefits of a large undertaking.

With project financing, part of the risk that otherwise would have been assumed by the equity participants is accepted by the lenders (usually banks). Should the investment fail, the lenders have no claim against the other assets of the equity participants because of their limited liability. As compensation for the additional risk lenders involved in project financing are subject to, they will require at least two things: first, a higher rate of interest on their loans, and second, some form of tangible security. In the case of the pipeline, security is available from two possible sources: fixed assets and a guaranteed revenue stream to the pipeline. While lenders would have first claim on the pipeline assets, they are not likely to assume operation of the pipeline and the assets are of little value in a broken up state. Hence the only real security for this project would be derived from contractual throughput arrangements.

A review of the coal slurry pipeline project's characteristics, relative to lenders' requirements, demonstrated that project financing was feasible. The project has a specific life span and the related cash flows can be uniquely identified with the project. Security to lenders could be offered through long term contracts which could contain provisions such as take-or-pay contract and price guarantees.

From the equity investors perspective, project financing is desirable. Use of project financing, by increasing leverage, reduces the amount of equity required and, as a result, reduces the over-all cost of capital for the project.

5.2 Capital Structure

Since financial leverage can be used to decrease the overall cost of capital for the project, the sponsors have an incentive to finance the project with as high a debt:equity ratio as they can negotiate with lenders. Financial leverage, however, creates financial risk. As the firm borrows more money the risk of default increases because the interest and principle must be paid according to a fixed schedule. Lenders will, therefore, require participating companies to pay a higher rate of interest as their indebtedness increases, thus placing a limit or ceiling on the beneficial use of leverage. Theoretically there is some optimal debt:equity ratio, with neither too much nor too little debt. In reality it is through the marketplace and negotiation that the optimal capital structure is found. It was assumed that a 75:25 debt:equity ratio would probably be the maximum debt position that the equity participants could negotiate with lender acceptance.

For a given debt:equity ratio there is more than one way to handle the interest on funds used during construction. In this analysis, it was assumed the debt:equity ratio would be maintained during construction. In other words, for every dollar required by the project (whether for a capital expenditure or an interest payment), 75 cents would be raised through debt and 25 cents through equity. At any time during the construction phase, therefore, the debt and equity would be equal to 75 per cent and 25 per cent respectively of the cumulative capital expenditures plus interest. In this way the debt:equity ratio is being held constant on the total capital requirements of the project.

5.3 Equity Considerations

A typical form of equity participation is one in which a number of corporations act as partners. Each partner is responsible for a percentage of the total equity requirements, and receives in return a portion of the resulting positive cash flows on a pro-rated basis according to their equity position.

The cost of equity depends on several factors including inflation, the business and technological risk of the project, the debt:equity ratio and its associated financial risk, and general equity market conditions. It is believed that a 20 per cent after tax rate of return on equity is probably a safe assumption for a preliminary assessment of financial viability. This is two percentage points higher than that assumed for the rail alternative. The higher cost of equity is a reflection of the greater degree of leverage (and thus also financial risk) assumed to be obtained by sponsors of the pipeline, and the relatively greater business and technical risk associated with the pipeline project. The greater business risk is in part due to the nature of the pipeline project, which gives management very little flexibility to reduce costs if the volume of coal shipments is lower than expected.

5.4 Debt Considerations

The cost of debt for the pipeline project was assumed to be equal to the forecast inflation rate, plus 8½ per cent. The 8½ per cent is an estimate of what the market would demand to compensate investors for financial risk, business risk, and the general uncertainty which existed in the capital market in 1982. Overall, the cost of debt worked out to about 16 per cent, before taxes. This is one percentage point greater than the cost of debt for the railway.

It was assumed that the total project debt would be repaid in equal annual installments within the first twenty years of the operating life of the pipeline. Because financing is not currently available for this long of a term, the outstanding debt would likely have to be refinanced at the end of the first ten year term of indebtedness.

It should be pointed out that these debt financing costs may be fairly conservative. This analysis was undertaken when interest rates were near their peak, and therefore the cost of debt may be abnormally

high. In addition, it is conceivable that the pipeline project sponsors could negotiate a special financing arrangement with the foreign purchasers of the coal which would enable them to lower the cost of debt considerably.

5.5 Taxation

A corporate partnership was assumed so that the sponsor companies could begin to utilize the maximum capital cost allowances as tax write-offs against other sources of company income in the same year in which the capital expenditures are incurred. In fact, all the tax losses during the construction and start up phases of the project were assumed to offset other sources of corporate income, thus providing a positive cash flow to the equity holders in the form of tax relief.

The approximate percentage of total pipeline capital expenditures falling into each capital cost allowance asset class is outlined in Table 3. Canadian and British Columbian corporate tax rates of 36 per cent and 16 per cent respectively were also assumed. There were no significant tax credits for the assets pertaining to the pipeline project.

TABLE 3:

PERCENTAGE OF SLURRY PIPELINE CAPITAL EXPENDITURES IN EACH CAPITAL COST ALLOWANCE ASSETT CLASS

Asset Class	Capital Cost Allowance	Per Cent of Capital Expenditures
3 - buildings	5% declining balance	51
2 - pipes and piping materials	6% " "	29
6 - storage tanks	10% " "	1
8 - machinery and equipment	20% " "	6.5
10 - temporary construction facilities	30% " "	8
22 - movable equipment	two year write-off	2
Expenses - operating costs	one year write-off	2.5
		100.0

CHAPTER 4 THE RAIL OPTION

1. THE RAIL ROUTES

Every effort was made to design a rail system as comparable as possible with the coal slurry pipeline system. As was the case with the pipeline, the coal was assumed to originate at five mine sites an average distance of 16 kilometres from Coalspur. Two alternative routes were evaluated for moving the coal by unit train from Coalspur to the nearby Canadian National Railways' mainline. As shown in Figure 3, the coal could be moved from Coalspur over existing track to the mainline at Bickerdike. This is the Bickerdike route. Unfortunately, the existing track has long steep grades and sharp curves. To operate over this rail line, the coal trains would have to be split in half, greatly reducing the economies of a unit train operation. To overcome these operating restrictions, a second route involving the construction of a 43 kilometre diversion from Coalspur to Obed on the mainline was also considered. This is the cutoff route.

The Canadian National Railways' mainline would be utilized to deliver the coal to a terminal located at the Port of Prince Rupert in British Columbia. By the Bickerdike route, the distance from the mines to the coal terminal is 1,390 kilometres (864.2 miles)[1]. By the cutoff route, this distance could be reduced to 1,337 kilometres (831.2 miles). It was reasonable to assume the rail system would terminate at Prince Rupert instead of at Kitimat because the existing track between Terrace and Kitimat is in poor condition, and because Prince Rupert is committed to having a great deal of rail infrastructure in place by 1990, when the Coalspur mines would begin to ship coal.

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[1]For a more detailed route description, refer to the Rail Appendix, page 71.

2. THE RAIL SYSTEM

The rail system includes all the facilities and equipment required to prepare, transport, and handle the coal between the mine site and the ocean vessel. It can be divided into three separate components: the coal preparation and loading facilities at the mine site, the railway line and rolling stock, and the coal terminal at the port site. Throughout the anaylsis, these three components were treated as separate cost centres and then combined to form the rail option. The coal loading facility at the mine and the coal terminal at the port were both designed to accommodate a unit train operation.[2]

3. THE COSTING PROCEDURE

The following comments relate to both the capital and the operating cost estimates for the rail system.

3.1 Incremental Costs

Throughout the analysis, estimates were generated for the incremental capital and operating costs associated with 10.2 and 18.2 million tonnes of incremental coal traffic. With respect to capital costs, estimates were made of the capital investment the railways would have to make for facilities and equipment to handle the addition of 10.2 and 18.2 million tonnes of coal to the rail system. The facilities and equipment of interest are those required to handle these additional volumes. It was anticipated, for example, that the railway mainline between Bickerdike and Tete Jaune would be double tracked by 1990, when the first coal shipments from the Coalspur mines would begin moving to Prince Rupert. This section of track would be able to handle the additional traffic from Coalspur without any further improvements. Therefore, no fixed plant costs for this stretch of track were allocated to the Coalspur traffic in the study.

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[2] For a detailed description of the unit train operation, refer to the Rail Appendix, page 71.

Thus the tariffs calculated reflect only the incremental costs of moving the designated annual throughputs. This is a reasonable assumption given that the costs for the infrastructure already in place would be recovered from other railway traffic if these additional volumes of coal were not moved. In other words, if the railways were to transport this coal at the minimum rates calculated they would recover all cost outlays and earn a return equal to their cost of capital. This does not mean they have to change these rates. After accepting the traffic,competitive conditions may permit them to assess rates greater than the minimum,thereby making a contribution toward other system costs.

3.2 Common and Joint Costs and Benefits

It was not possible to take into account the common and joint costs and benefits associated with the incremental coal traffic from Coalspur. These costs and benefits would be shared with other rail traffic, and any attempt to pro-rate the share attributable to any particular traffic segment would have been arbitrary. With respect to costs, no allocation was made to the Coalspur traffic for the more rapid consumption of railway assets utilized by the new traffic, which would be in place when shipments begin in 1990. For example, no costs for the consumption of mainline fixed plant between Bickerdike and Tete Jaune were charged to the Coalspur traffic in the analysis. With respect to benefits, no allocation was made to other traffic which may benefit from capital improvements made for the Coalspur traffic. These costs were assumed to be totally recovered from the new coal shipments. This analysis implicitly assumes that the common and joint costs associated with the new coal traffic would offset the common and joint benefits.

4. CAPITAL COSTS

4.1 Coal Preparation and Loading Facilities

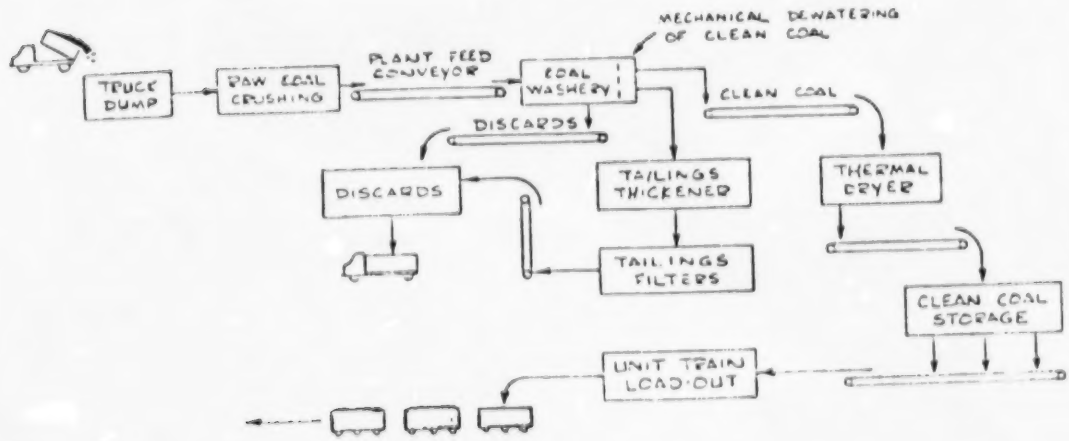
A typical coal preparation and unit train loading system is shown in Figure 4. In this study, costs were not included for truck dumping,

raw coal crushing, initial coal washing, or for the processing of discards and tailings because these operations would be required whether the coal was shipped by rail or by slurry pipeline. Only the facilities unique to either mode were costed.

Since the rail system would require more extensive coal washing than the slurry system, the additional wash plant costs were estimated. The coal is thermally dried to a moisture content of between 10 and 15 per cent and then stored in silos. (Thermal drying equipment to dry the coal to between 10 and 15 per cent total moisture was also unique to the rail operation. In addition, a clean coal handling system would be required to move the coal from the thermal dryer to storage silos and then to an outside emergency stockpile.) The rail car loading facility would recover the coal from storage, weigh it, and load it into rail cars. The capital cost of these coal preparation and loading facilities is summarized in Table 4. Based on the level of detail in the engineering and on the cost estimating techniques used, it is anticipated that the actual cost of these facilities would be plus or minus 25 per cent of the amounts shown.

FIGURE 4:

COAL PREPARATION AND UNIT TRAIN LOADING SYSTEM



Source: Letter from Simon-Carves of Canada Ltd. re "Capital and Operating Costs of Coal Preparation and Handling Plants", June 11, 1982, page 2.

TABLE 4:

THE RAIL OPTION: SUMMARY OF
CAPITAL AND OPERATING COSTS AND FINANCING ASSUMPTIONS

(in millions of 1981 dollars)

	Throughput	
Capital Costs	10.2 Million Tonnes	18.2 Million Tonnes
Coal Preparation and Loading Facilities	126.370	152.176
Railway Line and Rolling Stock		
Bickerdike Route	591.2	1,065.5
Cutoff Route	642.6	1,119.7
Coal Terminal	180.7	222.0
TOTAL CAPITAL COSTS:		
BICKERDIKE ROUTE	898.27	1,439.676
CUTOFF ROUTE	949.67	1,493.876
Annual Operating Costs		
Coal Preparation and Loading Facilities	8.008	13.995
Railway Line and Rolling Stock		
Bickerdike Route	86.1	154.6
Cutoff Route	81.1	145.6
Coal Terminal (including lease)	19.3	26.6
TOTAL ANNUAL OPERATING COSTS:		
BICKERDIKE ROUTE	113.408	195.195
CUTOFF ROUTE	108.408	186.195

Financing Assumptions	Debt:Equity Ratio	Cost of Debt (before tax)	Cost of Equity (after tax)
Coal Preparation and Loading Facilities	70:30	15%	18%
Railway Line and Rolling Stock	40:60	15%	18%
Coal Terminal	70:30	15%	18%

4.2. Rail Line and Rolling Stock

After it had been projected what rail fixed plant would likely be in place by 1990, costs were estimated for the additional improvements in the rail system required to handle the Coalspur traffic. Capital investment in the rail line would be required for construction of five 16 kilometre spur lines from the mine sites to Coalspur, and improvement of the mainline from Obed to Prince Rupert. Construction of a new 43 kilometre line from Coalspur to Obed would only be required for the cutoff option.

A capital outlay would also be required to purchase the locomotives, rail cars, and cabooses which make up the unit train sets. It was assumed the rolling stock would last the entire 35 year life of the project, with no reinvestment to replace any equipment before 2024. In reality, the average useful life of a rail gondola rail car is about 30 years. However, any reinvestment taking place so far in the future would be insignificant in the analysis because the cost would be discounted over a very long period of time. Based on the level of detail in the engineering and on the cost estimating techniques utilized, it is anticipated that the actual cost of these capital additions would be plus or minus 30 per cent of the amounts shown in Table 4.

4.3 Coal Terminal

The cost of adding on to the coal terminal at Prince Rupert to handle between 10.2 and 18.2 million tonnes of coal per year was estimated from information obtained from Ridley Terminals Inc. of Vancouver. Costs were generated for the construction of a terminal with off-dock berthing facilities, and for the purchase and installation of major pieces of equipment. No specific level of accuracy was assigned to these estimates.[3]

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3 For a detailed description of the capital costs associated with the rail alternative, see the Rail Appendix, page 71.

5. OPERATING COSTS

Incremental operating costs were also estimated for each cost centre of the rail system.

5.1 Coal Preparation and Loading Facilities

Direct operating costs were estimated for the coal preparation and loading facilities unique to the rail system. These facilities are described under Capital Costs. The operating cost estimates include equipment and supplies, power and lighting, space heating, dryer fuel, and labour. The accuracy of these costs was estimated to be plus or minus 25 per cent.

5.2 Rail Transportation

Railway operating costs were estimated so as to take into account the operating characteristics of the territory involved and the characteristics of the particular movement including routing, distance, commodity type and weight per car. The estimated annual operating costs for the 108 car unit train operation are summarized in Table 4. As expected, the operating costs for the cutoff route are lower than for the Bickerdike route, reflecting the operating efficiencies that could be achieved with the construction of the cutoff.

5.3 Coal Terminal

Annual operating costs for the coal terminal were estimated for 10.2 and 18.2 million tonne facilities based on information supplied by Ridley Terminals Inc. of Vancouver. The estimates include annual maintenance costs, on-site power costs, overhead office expenses, and lease costs. No specific level of accuracy was assigned to these estimates.

In keeping with current practice in Canada, site preparation costs were assumed to be recovered through an annual lease paid by the terminal operator. Site preparation work is usually financed by the National Harbours Board and then recovered from the terminal operator through lease payments. In this analysis, site preparation costs were estimated based on current construction costs at the Port of Prince Rupert. For the 10.2 million tonne facility, site preparation costs were estimated to be $36.2 million in 1981 dollars. For the 18.2 million tonne facility, this increased to $62.5 million. These costs were translated into annual lease payments that would generate an 18 per cent return over a 20 year period. In 1981 dollars, the annual lease payment for a 10.2 million tonne coal terminal amounted to $6.8 million. For an 18.2 million tonne terminal, the annual lease payment would be $11.6 million. Lease payments were assumed to begin in 1990, and to continue throughout the life of the project.

6. TIMING OF EXPENDITURES

The five mines were assumed to come on stream six months apart. The first mine would begin to ship coal in January 1990, and the last mine would commence production in January 1992. Construction of the coal preparation and loading facilities was assumed to begin one year before each mine would come on stream. Thirty per cent of the total expenditure for all five mines would be incurred in 1989, 40 per cent in 1990, and 30 per cent in 1991.

Rail spur construction was assumed to begin six months before each mine would come on stream. Twenty per cent of the total expenditure for all five mines would be incurred in 1989, 40 per cent in 1990, and 40 per cent in 1991. Construction of the cutoff rail line between Coalspur and Obed was assumed to begin in 1989, one year before the first mine would come on stream. The new line would be completed by 1990.

Rail mainline upgrading required to move 10.2 million tonnes of additional coal traffic was assumed to commence in 1989, one year before the first mine would begin to ship coal. About 20 per cent of the total estimated expenditure for upgrading would be incurred in 1989, 40 per cent in 1990, and 40 per cent in 1991. The upgrading required to move 18.2 million tonnes of coal would begin in 1988, two years before the first mine would come on stream. It was estimated that 20 per cent of the total expenditure would occur in 1988, 20 per cent in 1989, 30 per cent in 1990, and 30 per cent in 1991.

Expenditures for rolling stock were assumed to occur over a 3 year period as the mines begin to extract coal. About 40 per cent of the total expenditure would be incurred in 1990, 40 per cent in 1991, and 20 per cent in 1992.

The coal terminal at Prince Rupert was assumed to be in place by 1990 to receive the first coal shipped from Coalspur. Construction of the terminal and installation of major equipment would take place in 1988 and 1989. About two thirds of these costs would occur in 1988, and one third in 1989. For the 10.2 million tonne terminal, all site preparation costs were assumed to occur in 1987. For the 18.2 million tonne terminal, site preparation costs were assumed to occur in 1986 and 1987.

Operating costs for all components of the rail system were phased-in according to the number of mines on stream. Thirty per cent of total annual rail operating expenditures were assumed to occur in 1990, 70 per cent in 1991, and 100 per cent in 1992 and each following year until 2024.

7. FINANCING ASSUMPTIONS

As mentioned earlier, each part of the rail system was treated as a separate cost centre. The coal preparation and loading facilities, the rail line and rolling stock, and the coal terminal were all treated as if they were owned by different corporate entities.

Investment in each part of the rail system was assumed to be financed on a corporate basis. Unlike project financing, corporate financing allows the investment and financing decisions to be made separately. If the project is approved it is financed with available cash. The cost and source of these funds were assumed to be obtained from debt and equity lenders in the same proportion existing for the entity as a whole.

A debt:equity ratio of 70:30 was assumed for the coal preparation and loading facilities and for the coal terminal. This debt:equity ratio may be rather high for corporate financing, but in the absence of more reliable information, this optimistic financing assumption was utilized in the analysis. The sensitivity of the analysis to this assumption is discussed in Chapter 6. Investments in the rail line and rolling stock were assumed to be financed in accordance with the Canadian National Railways' legislated maximum debt:equity ratio of 40:60.

All the rail cost centres were financed with an 18 per cent cost of equity, after taxes. The cost of debt was assumed to be equal to 15 per cent, before taxes. This includes an allowance for inflation, the real rate of return and business risk. The debt was assumed to be carried in a manner consistent with corporate financing. No debt repayment period was specified because with corporate financing, debt is not secured for specific projects but for the corporation as a whole. Debt is repaid with general corporate funds. As with the slurry pipeline, it was assumed all cost centres would take full advantage of applicable capital cost allowances.

CHAPTER 5 MINIMUM TARIFFS

Utilizing the assumptions outlined in previous chapters, a series of nominal minimum tariffs was calculated for the rail and slurry pipeline projects for the years 1990 to 2024. These tariffs are illustrated in Figure 5 for 10.2 million tonnes of throughput. When the revenue generated by each tariff stream is discounted back to the first year of operation at the weighted average cost of capital, it equals the present value of the project's costs discounted to the same year. Since it was assumed that rail and slurry pipeline tariffs would grow at the same rate, the mode with the lowest tariff in 1990 would continue to have the lowest tariffs over the life of the project. Therefore, only the 1990 tariff levels are discussed in this chapter.

1. RAIL AND SLURRY PIPELINE TARIFFS

The railway tariff for 10.2 million tonnes throughput was estimated to be $52 per tonne for the Bickerdike route and $53 for the cutoff route. For the same annual throughput the tariff for the pipeline with a 55 per cent slurry terminal was calculated to be $48 per tonne. It can be seen that the tariff for the pipeline with a 55 per cent slurry terminal is $4 or approximately 8 per cent less than the most economical (Bickerdike route) rail tariff.

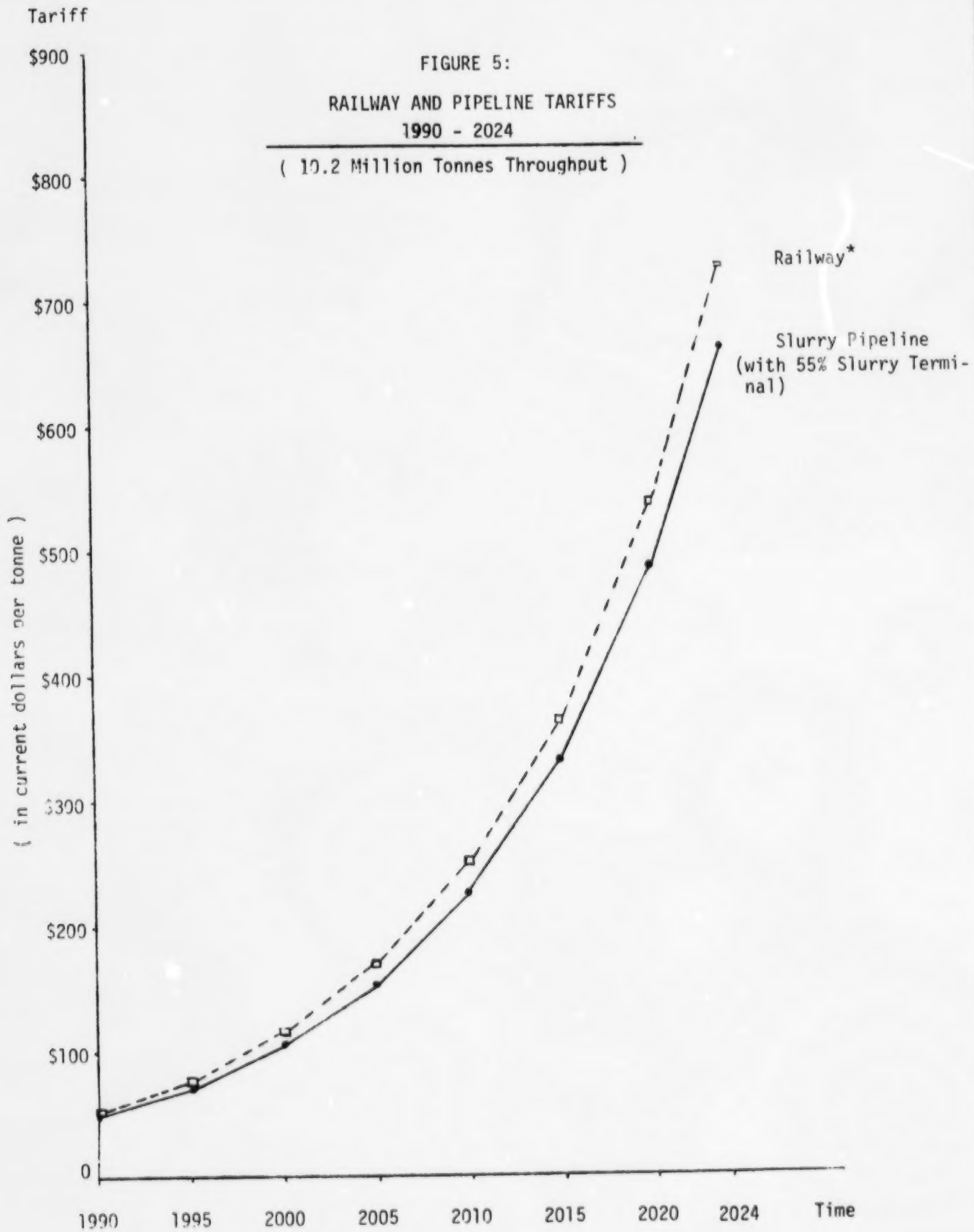
If the annual throughput is raised to 18.2 million tonnes, the rail tariff is estimated to drop from $53 to $44 for the cutoff route and from $52 to $50 for the Bickerdike route. The pipeline tariff falls from $48 to $36 (see Figure 6). At this volume of throughput the tariff for the pipeline with a 55 per cent slurry terminal is $8 or approximately 18 per cent lower than the most economical (cutoff route) rail tariff. While the least cost rail alternative for 10.2 million tonnes throughput is the Bickerdike route, it is the cutoff route for 18.2 million tonnes throughput.

FIGURE 5:

RAILWAY AND PIPELINE TARIFFS

1990 - 2024

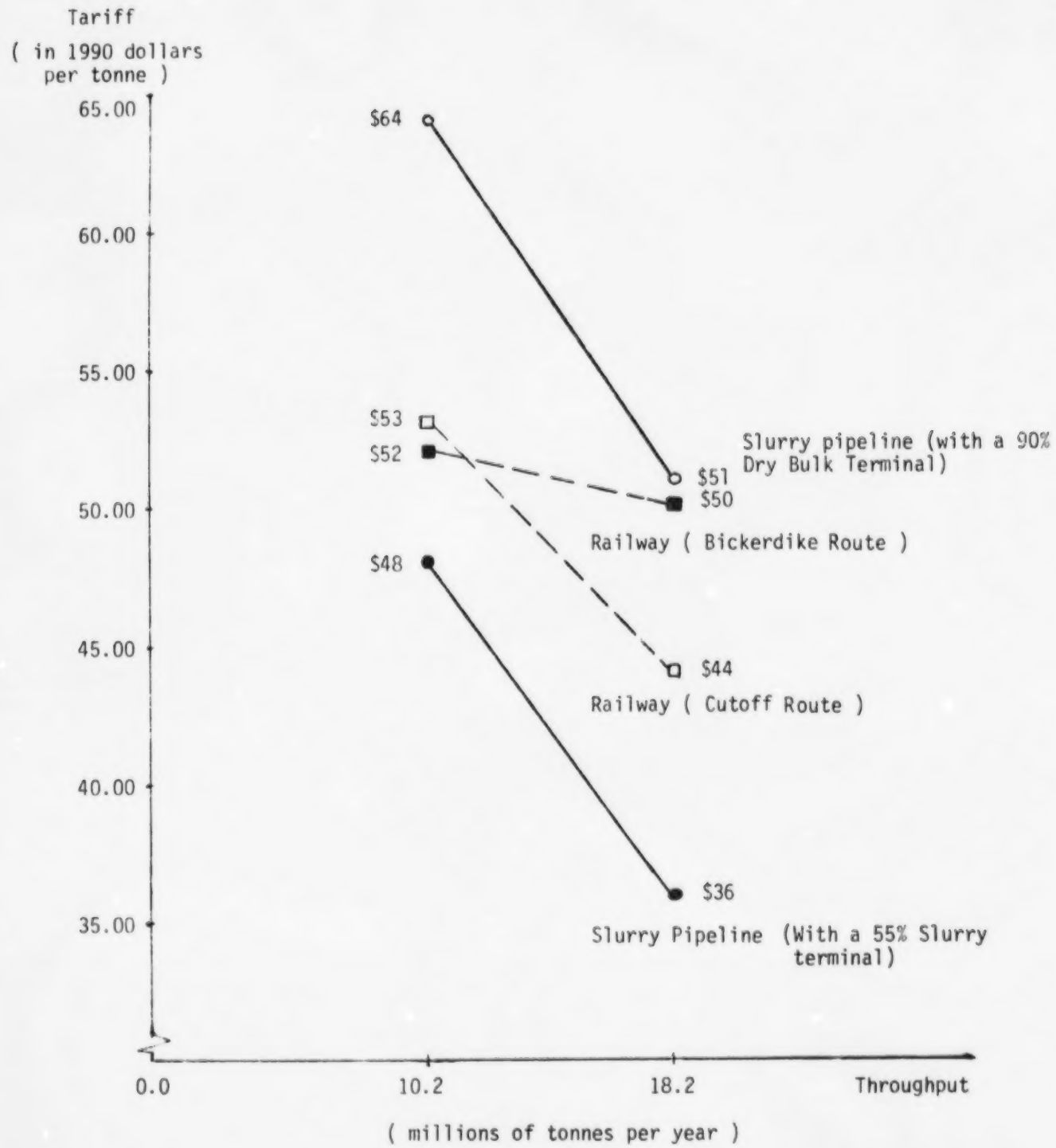
(10.2 Million Tonnes Throughput)



*At 10.2 million tonnes throughput, the Bickerdike and cutoff routes produce approximately the same tariffs over the life of the project.

FIGURE 6:

RAILWAY AND SLURRY PIPELINE TARIFFS IN 1990



As discussed previously, the user of the slurry pipeline system has the opportunity to select the optimal degree of dewatering at the west coast port site. Since the exact amount of drying required has not been determined, the maximum dewatering scenario (drying the coal to a moisture content of 10% by weight) was analysed for comparison purposes. It must be cautioned that drying coal crushed for slurry transport to this degree would make it impractical to handle and thus in reality would not be done before the coal arrives at its destination. However, this scenario in conjunction with the slurry terminal (no dewatering) scenario provides the range of dewatering possibilities. [1]

The estimated tariffs for the Dry Bulk Terminal scenario are $64 and $51 for the annual throughputs of 10.2 and 18.2 million tonnes respectively. These tariffs are 23.1 and 15.9 per cent higher than the least cost rail tariffs.

Figure 6 shows graphically the tariffs estimated for 1990 for the two railway and pipeline scenarios described above. From this graph a number of observations can be made. First, and most importantly, is the close proximity of the rail and pipeline cases. Given the level of accuracy attached to the capital and operating costs estimates, the rail and pipeline tariffs are not significantly different enough to clearly establish which mode of transportation would be the most cost competitive.

The graph on Figure 6 also indicates quite clearly the importance of the dewatering decision and the throughput decision. As the amount of dewatering is decreased the cost competitiveness of the pipeline is greatly enhanced. The impact of dewatering is further discussed in Chapter 6. Also increasing the annual volume of throughput from 10.2 to 18.2 million

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[1] A detailed analysis of the dewatering options and the dry bulk scenario is contained in Section 1 of Chapter 6 of this report.

tonnes causes the pipeline tariff to drop by a greater percentage than the rail tariffs (by 25 per cent versus 4 per cent and 17 per cent for the Bickerdike and cutoff routes respectively). It can be asserted, therefore, that the pipeline exhibits greater economies of scale than does the unit train operation. This result is not unexpected as both the operating and capital costs of the pipeline exhibit significant economies of scale. In the rail alternative, however, only the capital costs of the coal preparation and loading facilities, the coal terminal, and the operating costs of the coal terminal exhibit major economies of scale.

In Figure 6 straight lines are drawn connecting the tariffs for 10.2 and 18.2 million tonnes of throughput per year. One would expect each mode to exhibit economies of scale at a decreasing rate as volume is increased, and thus curves convex to the origin would be more realistic than the linear relationship implied here. Nevertheless, these tariff estimates and inter-connecting straight lines give a general indication that the operating efficiency gain from building the cutoff track between Coalspur and Obed outweighs the additional capital expenditures at an approximate annual throughput of 11 million tonnes.

1.1 Calculation of Rail Tariffs

It will be recalled that the rail system can be divided into three separate components: the coal preparation and loading facilities at the mine site, the railway line and rolling stock, and the coal terminal at the port site. The calculated rail tariffs are comprised of the sum of the estimated tariffs for each of these cost centres. Figure 7 graphically illustrates the breakdown of the total rail tariff into the loading, rail transport and coal terminal components for the Bickerdike and cutoff routes at both levels of throughput. Similarly,

the pipeline system is comprised of the water gathering system, the slurry preparation plants, the main pipeline and pump stations, and the slurry terminal. In the case of the pipeline, however, all these facilities were assumed to be owned by the same corporate entity, and consequently only a single total tariff was estimated.

2. RAIL RATE FORECASTS

The minimum tariff calculations do not take the demand for the transportation service into consideration. As discussed in chapter 4 the rates calculated in this analysis do not make any provision for contribution to other railway costs. Therefore, it is interesting to compare forecasts based on actual rail rates in 1990 with the minimum rail rate calculated in this chapter for 10.2 million tonnes of throughput.

Four different rail rate forecasts are compared in Figure 8 with the calculated rail tariff for the cutoff route. The forecasts were generated by applying different rates of inflation to existing rail rates. Scenario C is particularly worth noting. It was calculated by escalating current railway rates at the expected rate of inflation, and the resulting forecast ($37) is fairly close to the tariff estimated for the cutoff route at the 10.2 million tonne level of throughput ($39). Hence the forecast rail rates compare favourably with the rail tariffs generated in the analysis when similar assumptions on inflation are made.

A similar rate forecast was also prepared for coal terminal throughput charges. Again, the application of expected inflation rates to current coal terminal charges did not yield a forecast significantly different from the tariffs calculated in this analysis ($8.79 forecast versus $8.97 calculated).

FIGURE 7:

BREAKDOWN OF 1990 RAIL TARIFF

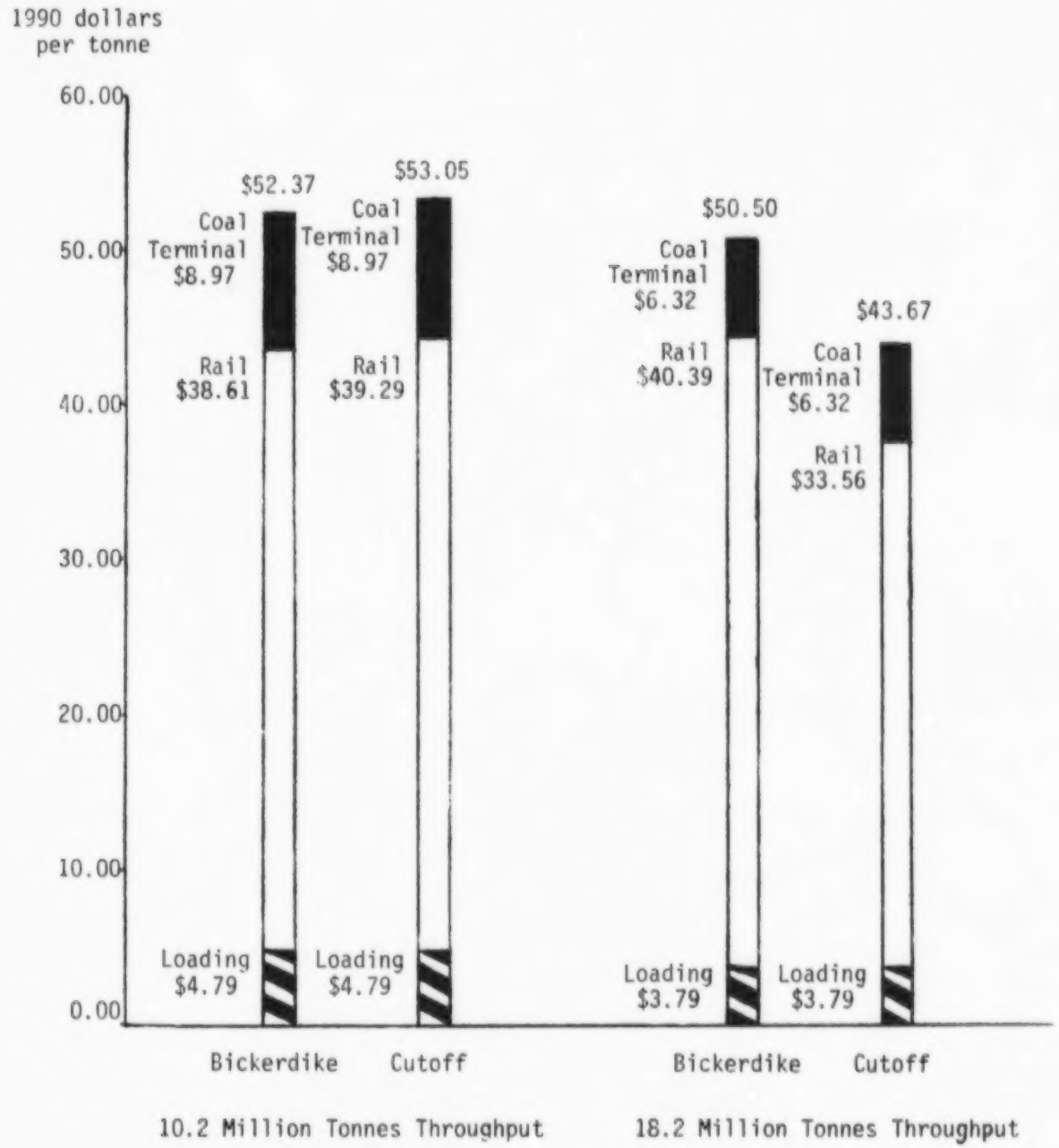
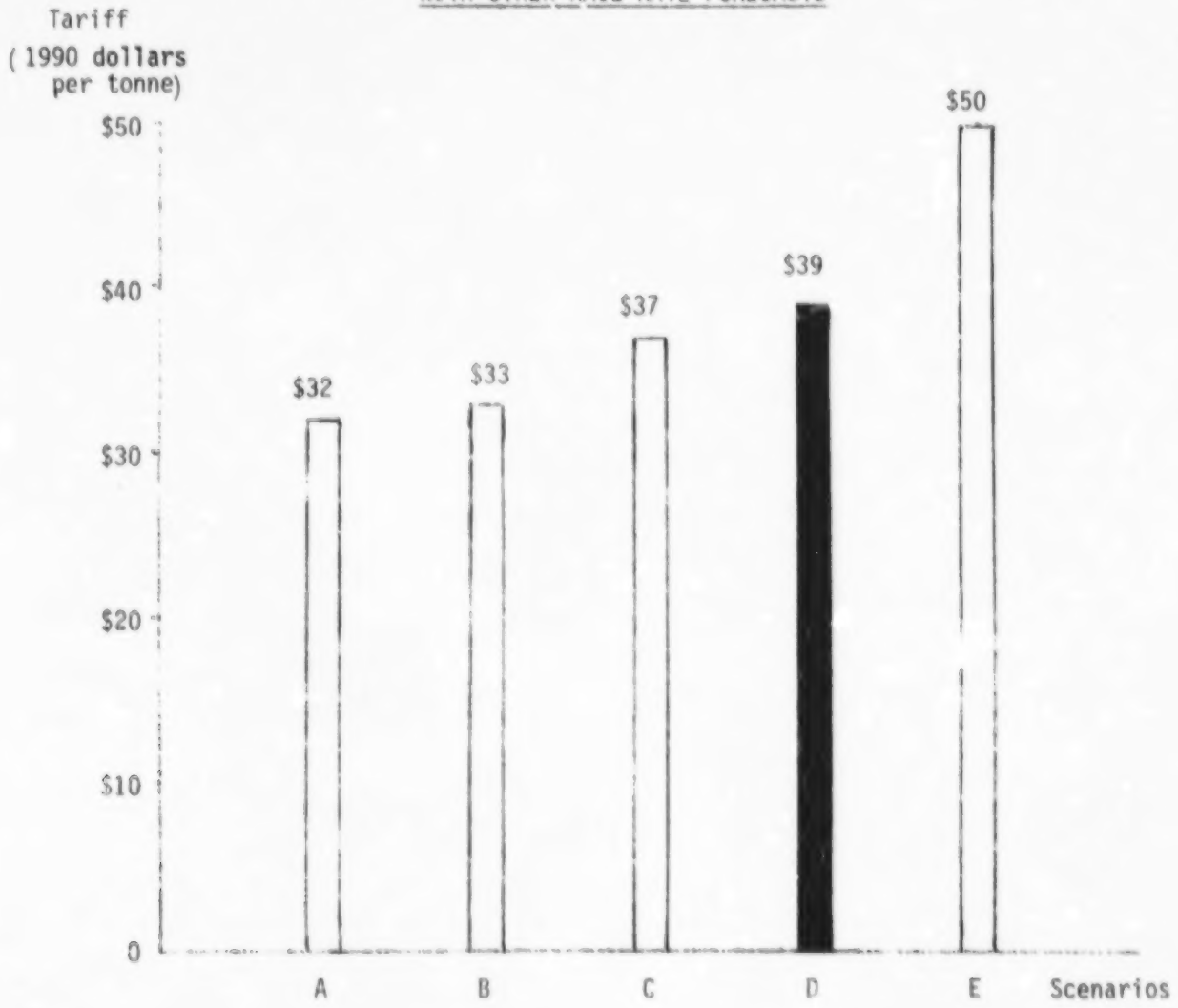


FIGURE 8:

COMPARISON OF THE MINIMUM RAIL TARIFF FOR THE CUTOFF ROUTE WITH OTHER RAIL RATE FORECASTS



Scenario A: Current railway rates inflated assuming that operating costs will increase at the expected inflation rate, while capital costs remain constant.

Scenario B: Current railway rates inflated by 8 per cent per year.

Scenario C: Current railway rates inflated by expected inflation rates.

Scenario D: Minimum rail tariff calculated for the cutoff route at 10.2 million tonnes throughout.

Scenario E: Current railway rates inflated by the average rate of increase during the five years previous to 1982 (13.83 per cent).

CHAPTER 6 SENSITIVITY ANALYSIS

This chapter deals with the sensitivity of the rail and slurry pipeline tariff schedules to the major assumptions made in the analysis. The railway cutoff route and the pipeline with a 55 per cent slurry terminal, both at annual throughputs of 10.2 million tonnes, are the base cases that are compared with the sensitivity tests. The results of the sensitivity analysis are summarized in Table 6 at the end of the chapter.

1. SLURRY DEWATERING

In the Fluor report five alternative marine terminals were designed and costed, each varying the degree of dewatering the coal water slurry mixture would undergo. The various terminal configurations can be briefly described as follows:

- A slurry terminal with no mechanical dewatering. The slurry, after being allowed to settle in storage ponds, would be loaded by pipeline directly onto ocean transport carriers at a concentration of 55 per cent coal by weight.

- A slurry terminal with partial mechanical dewatering to a concentration of 60 per cent coal by weight (the maximum concentration at which the slurry would maintain its fluid state). Again, the slurry would be loaded by pipeline aboard oceangoing carriers.

- Three dry bulk terminals where the slurry would be mechanically dewatered and then thermally dried to a concentration of 80 per cent, 85 per cent or 90 per cent coal by weight. The coal would be loaded aboard bulk carriers with conventional conveyor equipment.

The pipeline's capital and annual operating costs with the two slurry terminals and the three dry bulk terminals are summarized in Table 5. It is clear that both the pipeline's capital and operating costs increase significantly when the amount of dewatering is increased.

TABLE 5:

SLURRY PIPELINE CAPITAL AND OPERATING COSTS
WITH SLURRY AND DRY BULK TERMINALS

(in millions of 1981 dollars)

	Throughput	
	10.2 Million Tonnes	18.2 Million Tonnes
SLURRY PIPELINE CAPITAL COSTS		
Slurry Terminals		
55% coal by weight	1,676	2,225
60% coal by weight	1,763	2,353
Dry Bulk Terminals		
80% coal by weight	1,848	2,493
85% coal by weight	1,909	2,602
90% coal by weight	1,970	2,711
SLURRY PIPELINE ANNUAL OPERATING COSTS		
Slurry Terminals		
55% coal by weight	38.1	54.7
60% coal by weight	53.0	74.4
Dry Bulk Terminals		
80% coal by weight	60.8	91.4
85% coal by weight	67.3	103.0
90% coal by weight	73.7	114.6

Source: Fluor Canada Ltd., Coal Slurry Pipeline Feasibility Study 1981, November 1981, Contract 775412/703623, Executive Summary, pages 1-14 to 1-16.

The sensitivity of the slurry pipeline to dewatering costs was tested by recalculating the minimum tariffs with the 90 per cent dry bulk terminal costs instead of the 55 per cent slurry terminal costs. The 90 per cent dry bulk terminal includes the facilities and equipment necessary to dewater the slurry to 10 per cent total moisture. This is the maximum amount of dewatering investigated in the Fluor study, and it would produce a dry bulk material with a similar moisture content to coal shipped by rail. It is important to realize that in reality it is unlikely that the slurry would be dewatered to this extent because powdered coal with such a low moisture content would create severe handling problems due to its volatile and inflammable characteristics.

As mentioned at the beginning of this report, the moisture content of the coal exported overseas will depend on individual buyer's specifications. Current coal burning technology utilizes coal with a moisture content of 10 to 15 per cent. However, recent research indicates it may be feasible to burn coal with a moisture content of up to 35 per cent.[1] In the final analysis, the optimal amount of dewatering, and where it should take place, will have to be determined by considering the costs and benefits of handling, transporting and burning coal slurry between the mine and the power plant. This is an area where additional research is required.

It will be recalled from Chapter 5 that the 55 per cent slurry terminal, which includes no mechanical dewatering, yielded a minimum pipeline tariff of $48. When this was recalculated with the 90 per cent dry bulk terminal costs, the result was a pipeline tariff of $64. This is $16, or one third higher than the 55 per cent slurry terminal. When compared with the rail alternative, the tariff for the 90 per cent dry bulk terminal is $12 or about 23 per cent higher than the most economical Bickerdike route, which produces a tariff of $52. Recall that the 55 per cent slurry terminal tariff was $4 or approximately 8 per cent lower

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[1] J.K. Higgins (Editor), "Coal-Water Mixture Survives Fluidized Bed for Combustion Test," Coal Week, July 5, 1982, Vol. 8. No. 27

than the most economical rail tariff. According to these tariffs, a slurry pipeline with a 55 per cent slurry terminal would have a slight cost advantage over the most economical rail system, but the rail system would have a cost advantage over a pipeline with a 90 per cent dry bulk terminal. This clearly indicates that if a substantial amount of dewatering is required at the Kitimat terminal, then the cost competitiveness of the slurry pipeline would be significantly reduced.

2. REGULATION OF SLURRY PIPELINE TARIFFS

In this study it was assumed the pipeline operator would be free to charge a schedule of tariffs without regulator intervention. While other aspects of the pipeline such as public safety and environmental protection will likely attract government attention, there does not appear to be any compelling reason to regulate the rates of a coal slurry pipeline. The pipeline is likely to be linked corporately or contractually to the buyers and sellers who are directly involved in the system. Due to its nature the pipeline will have to be designed and financed to meet the particular needs of the participating users. Under these conditions it was deemed to be reasonable to assume there would be no rate regulation.

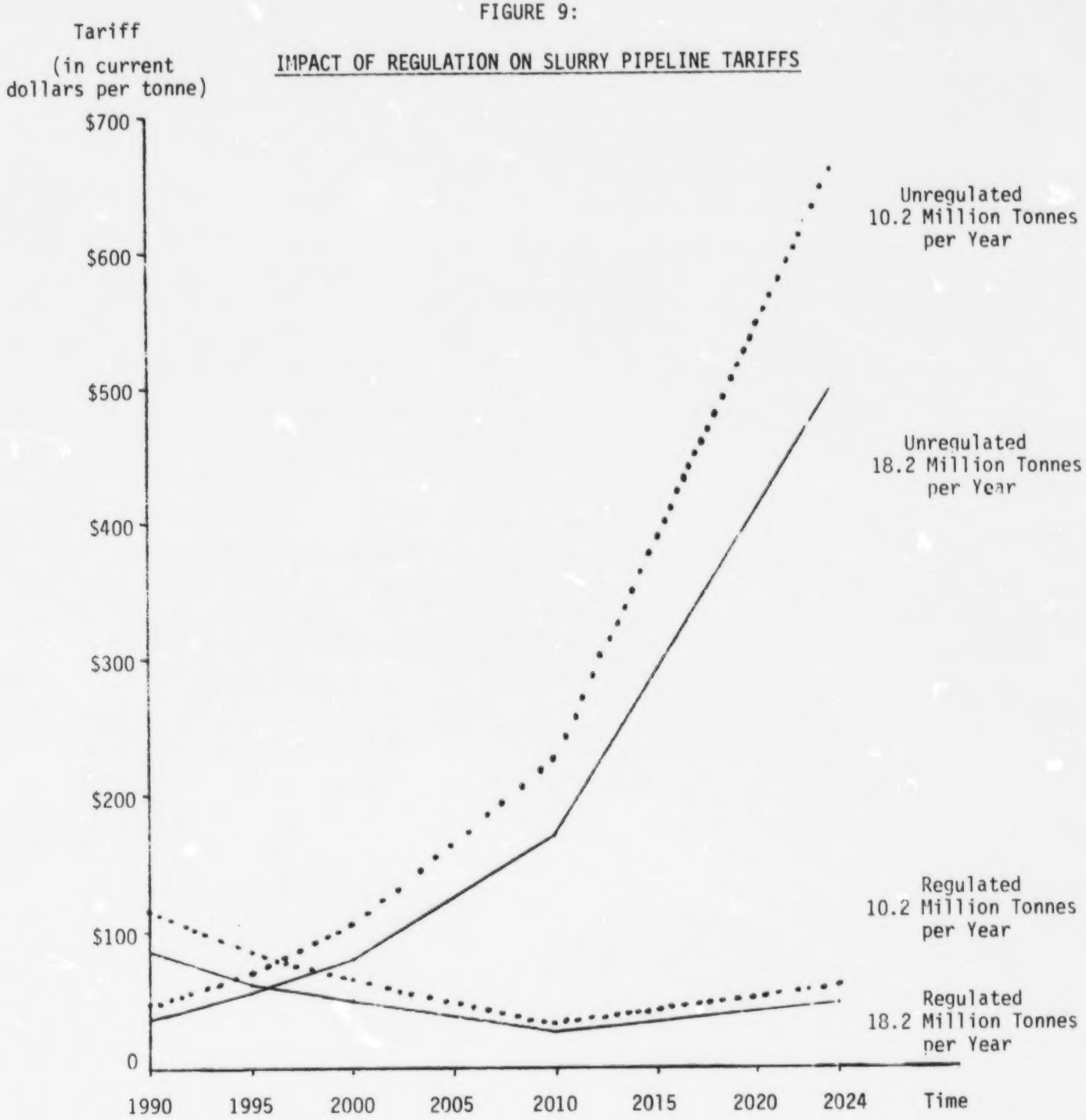
Were the pipeline to be regulated using the traditional rate base rate of return method of regulation, which is currently employed in the regulation of most inter-provincial oil and gas pipelines in Canada, a tariff schedule that differed considerably from that of an unregulated pipeline company would result. If the pipeline was regulated in this manner, the tariff would be set equal to the annualized cost of service and would consist of the following components: capital costs which include depreciation and a percentage return on the net book value that covers both interest payments on debt and a return on equity, corporate income taxes, and current operating costs.

For the purpose of this sensitivity, the asset base was assumed to be depreciated using the straight line method over the first twenty years of the slurry pipeline's life. The return on invested capital was based on the undepreciated value of the pipeline's assets or rate base. As shown in Figure 9, the tariffs start out at a very high level when the rate base is undepreciated but decline steadily each year as depreciation is taken. After 2010, when the rate base is fully depreciated, the tariffs vary directly with the pipeline's operating costs. Hence the traditional method of regulation produces what is called a front-end loading effect on the tariff schedule. The tariffs are very high in the early years of operation but are relatively low towards the middle and end of the pipeline's life when the rate base is close to or fully depreciated.

Three additional and inter-related factors accentuate the front-end loading effect on the coal slurry pipeline. First the slurry pipeline project is very capital intensive. As a result, the rate base and its associated capital charges (depreciation and return on the investment) would be very large relative to annual operating costs during the early years of the project's life. Second, for rate making purposes, interest on funds used during construction (calculated not only on debt but on 100 per cent of the capital expenditures) are capitalized or rolled into the rate base. For this reason high interest rates and a lengthy construction period result in interest costs during construction contributing a large proportion to total capital costs, and thus significantly to the overall size of the rate base and to the front-end loading effect. The third factor, inflation, is closely related to the above two factors. In addition to escalating the capital cost of a project, inflation has a serious impact on the interest during construction cost because interest rates tend to vary directly with the rate of inflation.

FIGURE 9:

IMPACT OF REGULATION ON SLURRY PIPELINE TARIFFS



From a business perspective, there are at least two advantages to this kind of tariff regulation. First, if there is a volume commitment, the rate of return on invested capital is guaranteed. And second, the high tariffs or cost of service at the beginning of operation allow for an early recovery of capital costs. Both of these advantages tend to lower the overall risk of a project.

The problem with this kind of regulated rate structure, however, is that the slurry pipeline would simply not be able to offer competitive rates to the railway during the initial years of operation. To be competitive, the pipeline operator would have to offer rates below the regulated maximum in the early years of operation. This lost revenue could not be recovered in subsequent years. The declining rate base in subsequent years will constrain the rate levels the pipeline is allowed to charge. Therefore, if rate base rate of return tariff regulation were required, it is unlikely that the slurry pipeline would ever be built.

The results of the sensitivity test verify these assertions. The 1990 tariff for the regulated pipeline assuming an annual throughput of 10.2 million tonnes was calculated at $114, which is more than double the unregulated pipeline tariff of $48. As can be seen in Figure 9, as the unregulated tariff grows steadily over time, the regulated tariff declines for a good portion of the project's life. Not until the rate base has been depreciated to a sufficiently small level do the operating costs become large enough to overtake the front-end loading, and thereby cause the tariffs to begin increasing.

In conclusion, the potential cost competitiveness of the coal slurry pipeline depends criticially upon it not being subject to the traditional cost of service method of regulation. This type of regulation results in a front-end loaded tariff schedule, which would make it impossible for the slurry pipeline to compete with the railway during the early years of operation.

3. INFLATION

Two sensitivity tests were done to determine how different assumptions on the impact of inflation would affect the cost competitiveness of each mode. In the minimum tariff calculations in Chapter 5, both modes' tariffs were assumed to grow at the same annual rate as operating costs. The annual rate of inflation for operating costs was assumed to stabilize at 8 per cent after 1996. In both of the following tests, the rate of inflation was increased by 1 per cent.

In the first test, this higher rate of inflation was assumed to impact on annual operating costs and on the tariff growth rate. This simulates what would occur if the rate of inflation increased but the prenegotiated terms of debt and equity financing did not change. The estimated rail tariff dropped by 5.7 per cent to $50, and the pipeline tariff dropped by 6.3 per cent to $45. This occurred because revenues increased more due to the higher tariff growth rate than operating costs increased due to inflation. The additional revenue made it possible to reduce tariff levels in the initial years while maintaining the same rates of return to debt and equity holders. Conversely,this test suggests that if the rate of inflation decreased by 1 per cent but the prenegotiated terms of debt and equity financing did not change, rail and pipeline tariffs would rise because the reduction in revenue would be greater than the reduction in operating costs.

In the second test, the higher rate of inflation was assumed to affect debt and equity rates in addition to operating costs and the tariff growth rate. This simulates what would occur if the rate of inflation increased and the terms of debt and equity financing were negotiated to reflect the changed market conditions. Under these conditions, the rail tariff declined by 0.9 per cent to $52.50, indicating the increased revenues from the higher tariff growth rate were almost offset by the higher operating costs and the increased return required by debt and equity holders. The pipeline tariff

increased by 6.3 per cent to $51. The revenue increase was overtaken by the higher operating costs and the increased returns required by debt and equity holders. Being more capital intensive, the slurry pipeline is more vulnerable than the railway to changes in the terms of debt and equity financing.

This suggests that if the rate of inflation decreased by 1 per cent, and the terms of debt and equity financing were renegotiated to reflect the changed market conditions, the rail tariff would rise marginally but the slurry pipeline tariff would fall significantly.

4. COST OF CAPITAL

Built into current debt and equity rates is an uncertainty factor of approximately 4 per cent over and above the historic relationship between real rates of return, inflation and market rates of interest. The minimum tariff calculations in Chapter 5 assumed this uncertainty factor would continue to exist at its current level of 4 per cent for the life of the project. The tariffs which resulted when this 4 per cent anomaly was removed are $42 and $35 reflecting a drop of 20.8 per cent and 27.1 per cent for the rail and pipeline respectively. The pipeline is more sensitive to this change than the rail alternative because it is more capital intensive. Therefore, if the structure of debt and equity rates returns to the historic norm, the cost competitiveness of the pipeline would be enhanced.

5. CAPITAL STRUCTURE

In this sensitivity test, rail and slurry pipeline tariffs were recalculated assuming all the cost centres of both modes were financed

with a 40:60 debt:equity ratio like the Canadian National Railways. The resulting tariffs were $54 and $80 representing a 1.9 per cent and 66.7 per cent increase over the base railway and pipeline tariffs respectively. As expected, the pipeline is much more sensitive to the proportion of debt in its capital structure than the railway, because a major portion of the rail alternative is already financed at a lower debt:equity ratio. These results highlight the importance of operating, sales, or financial guarantees that would allow potential pipeline investors to increase their leverage in the project.

6. COST OVERRUNS

The rail cost estimates used to calculate the minimum tariffs were considered more reliable than the slurry pipeline cost estimates, because rail technology is well established. With the relatively new slurry pipeline technology, a generous allowance had to be made for system unknowns. In this sensitivity test, the minimum tariffs were recalculated using the maximum cost overruns within the stated accuracy of the capital and operating cost estimates of each mode. For the rail system, capital and operating costs were assumed to exceed the estimated levels by 20 per cent. For the slurry pipeline system, capital and operating costs were assumed to be 30 per cent higher than was originally estimated.

This test shows the railway is more sensitive than the slurry pipeline to capital and operating cost overruns, because the rail tariff increases by a greater degree in response to a smaller percentage change in the cost estimates. The greater sensitivity of the rail tariff to changes in operating costs is not surprising since these costs are significantly greater for the rail option than they are for the pipeline. However, the greater sensitivity of the rail tariff to changes in capital

costs is surprising given the relatively larger capital outlays required for the pipeline project. This increased sensitivity can be accounted for by the higher proportion of equity in the capital structure of the rail project.

7. RAIL OPERATING ASSUMPTIONS

Although the rail system was costed assuming reasonable operating parameters, these are a function of a number of factors which determine the amount of rail congestion, such as rail line traffic and capacity forecasts. In this sensitivity test, another rail operating scenario was costed which shortened the unit train from 108 to 98 cars and increased the cycle time from 90 hours to 120 hours. This is essentially another cost sensitivity, because changes in these operating parameters directly affect the rail operating costs and the cash outlays required for rolling stock. No changes in any other cost aspect of the rail option was assumed. The resulting tariff was $56, representing a 5.7 per cent increase over the base case rail tariff. This indicates that the rail tariff is fairly insensitive to major changes in the basic operating assumptions.

8. REDUCTION IN THROUGHPUT

The tariffs of both modes were tested for their sensitivity to a drop of 20 per cent in the volume of coal shipped. This would be equivalent to the closing of one mine. The pipeline was assumed to operate at 80 per cent of its total capacity, but since its operating costs are essentially insensitive to volume changes, they were assumed to remain constant. The rail alternative is considerably more flexible, and therefore the operating costs of all three rail cost centres were assumed to drop by 20 per cent. It was also assumed that the incremental rolling stock required for one mine was not purchased, or could be sold or re-allocated to other traffic. All other rail capital

expenditures would have already occurred and therefore were not altered for this sensitivity test. The resulting tariffs are $57 for the railway and $60 for the pipeline. These rates are 11.3 and 25.0 per cent higher than the base rail and slurry pipeline tariffs, indicating the pipeline is considerably more sensitive than the railway to a drop in throughput below its design capacity.

TABLE 6:

SUMMARY OF SENSITIVITY TESTS

BASE CASES:	Minimum Tariffs (in 1990 dollars per tonne) Railway	Slurry Pipeline
(10.2 Million Tonnes Throughput)		
Railway Cutoff Route	$53.00	
Slurry Pipeline 55% Slurry Terminal.....		$48.00
SENSITIVITY TESTS:	**Change in Minimum Tariffs**	
1. Slurry Pipeline: 90% Dry Bulk Terminal	N/A ---	+ $16.00 + 33.3%
2. Slurry Pipeline: Rate Base Rate of Return Tariff Regulation	N/A ---	+ $66.00 + 138%
3. Inflation:		
(a) +1% on operating costs and tariff growth rate	- $3.00 - 5.7%	- $3.00 - 6.3%
(b) +1% on operating costs tariff growth rate, and debt and equity rates	- $0.50 - 0.9%	+ $3.00 + 6.3%
4. Cost of Capital Removal of uncertainty factor (-4% from debt and equity rates)	- $11.00 - 20.8%	- $13.00 - 27.1%
5. Capital Structure: Debt:equity ratio of 40:60 for all cost centres	+ $1.00 + 1.9%	+ $32.00 + 66.7%
6. Cost Overruns:		
(a) Capital Costs (Rail + 20% and Pipeline + 30%)	+ $11.00 + 20.8%	+ $11.00 + 22.9%
(b) Operating Costs (Rail +20% and Pipeline +30%)	+ $5.00 + 9.4%	+ $3.00 + 6.3%
7. Rail Operating Assumptions: Less efficient operating conditions	+ $3.00 + 5.7%	N/A ---
8. Reduction in Throughput: (20% less coal shipped)	+ $6.00 + 11.3%	+ $12.00 + 25.0%

CHAPTER 7 CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS

At an annual throughput of 10.2 million tonnes the rail and pipeline tariffs are not significantly different enough to definitively conclude which mode of transportation is the most cost competitive. Nevertheless, on the basis of this analysis, it can be concluded that the coal slurry pipeline is potentially cost competitive with a rail unit train system.

The following factors had an important impact on the relative competitiveness of the rail and slurry pipeline options.

(a) Slurry Dewatering

The pipeline's capital and operating costs increase significantly as the amount of dewatering is increased. For this reason, if the specifications of individual coal buyers require a substantial amount of dewatering, the cost competitiveness of the pipeline will be significantly adversely affected.

(b) Regulation of Slurry Pipeline Tariffs

The potential cost competitiveness of the coal slurry pipeline depends critically upon it not being subject to the traditional cost of service or rate base rate of return method of regulation, which is currently employed in the regulation of most pipelines in Canada. If regulated in the traditional manner, the front-end loading effect on the tariff schedule would place the pipeline in a position where it is unable to compete with the railway. Under these conditions it is not likely that the pipeline would ever be constructed.

(c) Inflation

A decrease in the rate of inflation which is assumed to affect debt and equity rates in addition to operating costs and the tariff growth rate enhances the relative cost competitiveness of the pipeline. This occurs because the pipeline is more capital intensive than the rail alternative and thus more vulnerable to changes in the terms of debt and equity financing. Conversely, an increase in the rate of inflation on the above mentioned components would decrease the pipeline's relative cost competitiveness.

(d) Cost of Capital

This study was conducted during a period when the cost of debt and equity financing were at unprecedented highs. As a result of its proportionally more capital intensive nature, the pipeline is relatively more sensitive to changes in the cost of debt and equity. Thus a reduction in the required market rates of return on debt and equity to more normal or historical levels would enhance the pipeline's cost competitiveness relative to the rail alternative.

(e) Capital Structure

The pipeline tariff is extremely sensitive to the proportion of the project which is debt financed. If it were necessary to finance the pipeline at a much lower debt:equity ratio (for example, at 40:60 instead of the assumed 75:25) then the cost competitiveness of the pipeline would be seriously reduced relative to the rail alternative, a major portion of which was assumed to be financed at the lower debt:equity ratio.

(f) Cost Overruns

The railway is more sensitive than the slurry pipeline to capital and operating cost overruns. The greater sensitivity of the rail tariff to

changes in operating costs is not surprising since these costs are significantly greater for the rail option than for the pipeline. Although the greater sensitivity of the rail tariff to changes in capital costs is surprising given the relatively larger capital outlays required for the pipeline project, it can be accounted for by the higher proportion of equity financing in the capital structure of the rail project.

(g) Reduction in Throughput

The pipeline's operating costs are relatively insensitive to the volume of coal shipped. A drop in the volume of throughput would, therefore, require that these costs and the capital costs be recovered from a smaller volume of coal, thus increasing the average transport cost per tonne. In contrast, the rail alternative is inherently more flexible when confronted with a drop in volume since excess capacity could possibly be allocated to other traffic. Hence the relative cost competitiveness of the pipeline would likely be hurt if investors perceived a significant risk of coal buyers being unable or unwilling to take the pipeline's optimal throughput.

(h) Financing

Conclusions (e) and (g) above highlight the need for secure long term take-or-pay contracts or other sales guarantees. A fairly high debt:equity ratio and the maintenance of the optimal throughput are essential if the slurry pipeline is to be cost competitive with the rail alternative. Operating or sales guarantees reduce the inherent risk in the project and thus increase the probability that a favourable financial package could be negotiated. Therefore, investment in the pipeline project by the coal buyers and/or sellers would likely be seen by debt funders as reducing the production and marketing risks in the project. Again, this would contribute to the negotiation of a favourable financial arrangement for the project.

(i) Economies of Scale

When the annual throughput was increased from 10.2 to 18.2 million tonnes, the pipeline was found to exhibit greater economies of scale than the unit train operation. Consequently, the pipeline's relative cost competitiveness is enhanced as the annual volume of throughput is increased.

2. RECOMMENDATIONS

In this analysis, the rail and slurry pipeline tariffs were too close to clearly establish which mode would be the most cost competitive coal transportation system. Putting this result in perspective, it must be remembered that compared with rail technology, slurry pipeline technology is relatively new. As a result, there is a greater opportunity for cost reducing innovations affecting pipeline capital and operating costs. In addition, this analysis was conducted during a period of high interest rates and economic uncertainty. These conditions have now changed significantly. It is therefore recommended that technical developments and financial conditions affecting the pipeline be surveyed on a regular basis, and that the impact of these changes on the competitiveness of the pipeline be assessed.

This report concentrated on the cost competitiveness of a slurry pipeline with a railway unit train operation. Given the close proximity of the costs of both modes, it is recommended that a comprehensive analysis be undertaken to assess the economic feasibility of the slurry pepeline project. This investigation should establish the cost per B.T.U. of producing, transporting, and burning coal in various combinations of slurry and dry bulk form. These results could then be compared to the cost per B.T.U. of dry coal shipped by a conventional railway system. This in depth study would most effectively be conducted by an industry or group of industries interested in expanding coal markets.

APPENDIX

This appendix contains a detailed treatment of the costs estimated for the rail mode and some background information used to estimate these costs.

Defining the route is a critical factor in determining the unit train cycle time and ultimately the number of train sets required to transport the desired annual throughput. This in turn impacts on the rail annual operating costs and the required investment in rolling stock. After the route was selected, it was then possible to estimate the investment in railway fixed plant(capacity) required to accommodate the additional traffic.

In addition to these topics, a detailed breakdown of the relevant capital and operating costs associated with the coal preparation and loading facilities for this mode are included.

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4. Operating Costs:

   (a) Operating Costs of Coal Preparation and Loading Facilities ..... page 78

1. THE BICKERDIKE ROUTE

From:	To:	Distance (in kilometres)	Canadian National Railways Subdivision
Mine site	Coalspur	16	Spur
Coalspur	Bickerdike	59	Foothills
Bickerdike	Jasper	156	Edson
Jasper	Red Pass	71	Albreda
Red Pass	McBride	102	Tete Jaune
McBride	Prince George	235	Fraser
Prince George	Endako	186	Nechako
Endako	Smithers	201	Telkwa
Smithers	Terrace	212	Bulkley
Terrace	Prince Rupert	152	Skeena
		1,390	

Source: Canadian National Railways
Mountain Region Timetable 7

2. THE UNIT TRAIN OPERATION

(a) Train Cycle Time

One-way running time, as determined from experience with existing unit trains, was estimated to be 28 hours. One-way terminal time was estimated to be 6.5 hours. This includes crew changes at Bickerdike, Jasper, McBride, Prince George, Endako, Smithers, Terrace and Prince Rupert, and train inspections at the mine site, Jasper, Prince George and Smithers. Loading and unloading time was assumed to be 8 hours per round trip. The resulting total estimated round-trip cycle-time is 77 hours. This was rounded out to 90 hours, allowing a 15 per cent contingency for delays in crew changes, inspections, loading and unloading.

(b) Train Sets

The number of train sets required was calculated by dividing the total annual throughput by the net tonnage that could be hauled by each train set during one year. The net tonnage that could be hauled by one train set was calculated by multiplying the capacity of one train by the number of cycles each train could complete in one year. The capacity of one train equals 108 cars multiplied by 92.5 tonnes per car, or 9,990 tonnes. The number of train cycles per year equals 7,680 available hours per year divided by 90 hours per cycle, or 85 train cycles. Available hours were calculated by multiplying 320 operating days per year by 24 hours per day. The number of operating days includes a 15 per cent contingency for work stoppages, slides, track maintenance, and other delays. Based on these calculations, the net tonnage that could be hauled by one train set each year equals 9,990 tonnes multiplied by 85 train cycles, or 849,150 tonnes. Therefore, 12.0 train sets would be required to haul 10.2 million tonnes of coal, and 21.4 train sets would be required to haul 18.2 million tonnes each year.

3. CAPITAL COSTS

(a) Capital Cost of Coal Preparation and Loading Facilities
(in millions of 1981 dollars)

	Throughput	
	10.2 Million Tonnes	18.2 Million Tonnes
Wash Plant	2.625	2.625
Conveying	22.320	22.320
Thermal Drying	25.810	51.616
Clean Coal Handling	57.510	57.510
Rail Car Loading	18.105	18.105
TOTAL CAPITAL COSTS	126.370	152.176

Source: Letter from Simon-Carves of Canada Ltd. re "Capital and Operating Costs of Coal Preparation and Handling Plants," June 11, 1982, Tables A and B.

(b) Capital Cost of the Railway Line

(i) Rail Spurs

The total costs for the construction of the five 16 kilometre spurs include the outlays required for siding tracks to store spare cars in addition to the main spur line itself. All cost estimates were based on the actual terrain over which the track would be built. These costs are summarized in Section (iv) under Investment in Railway Fixed Plant.

(ii) Cutoff Track

The alternative to breaking up the unit train between Robb and Bickerdike was the construction of 43 kilometres of new track between Robb and Obed. Contour maps were used to determine and cost a feasible route which would be compatible with design parameters currently in use for unit coal trains. The cost of constructing the cutoff track is also listed in Section (iv) under Investment in Railway Fixed Plant.

(iii) Summary of Rail Mainline Improvements

The following improvements would be required in addition to the upgrading forecast to be completed by Canadian National Railways by 1990. Cost estimates for these improvements are included in Section (iv) under Investment in Railway Fixed Plant.

	Throughput	
Section of Track	10.2 Million Tonnes	18.2 Million Tonnes
Bickerdike to Tete Jaune	None	None
Tete Jaune to Prince George	Signal Improvements High Speed Turnouts Yard Improvements	40 per cent Double Track High Speed Turnouts Signal Improvements Yard Expansion
Prince George to Prince Rupert	60 per cent Double Track Signal Improvement High Speed Turnouts Yard Improvements	80 per cent Double Track Signal Improvement High Speed Turnouts Yard Expansion

Source: DeLeuw Cather Canada Ltd. Unit Coal Train Study; Capital Cost of Fixed Plant - Coalspur Area to Prince Rupert. March 1982, page 11.

(iv) Investment in Railway Fixed Plant
(in millions of 1981 dollars)

Railway Fixed Plant	Throughput 10.2 Million Tonnes	Throughput 18.2 Million Tonnes
Rail Spurs	92.6	100.6
Cutoff Track	57.4	60.3
Robb to Coalspur Track	4.0	4.0
Tete Jaune to Prince George Mainline	14.5	102.0
Prince George to Prince Rupert Mainline	301.8	543.1
Total	470.3	810.0

Source: DeLeuw Cather Canada Ltd., Unit Coal Train Study: Capital Cost of Fixed Plant - Coalspur Area to Prince Rupert, March 1982, page 14.

(c) Capital Cost of Rolling Stock
(in millions of 1981 dollars)

	Throughput 10.2 Million Tonnes	Throughput 18.2 Million Tonnes
Bickerdike Route	178.3	315.8
Cutoff Route	172.3	309.7

These costs were calculated as follows:

(train sets x 1.1) x [(4 x price per locomotive) + (108 x price per gondola rail car) + price per caboose] = Capital Cost of Rolling Stock

The 1981 unit purchase prices of the required equipment are as follows:

SD40 - 2 Locomotives	$ 1,500,000
Bath Tub Gondolas	65,000
Caboose	50,000

The train configuration utilized in these calculations is based on actual Canadian National Railways unit train movements from mines in the Hinton area to Canadian west coast coal terminals. Rolling stock estimates for the Bickerdike route include the purchase of four additional locomotives to power the second half of the unit train between Coalspur and Bickerdike.

4. OPERATING COSTS

(a) Operating Costs of Coal Preparation and Loading Facilities
(in millions of 1981 dollars)

	Throughput	
	10.2 Million Tonnes	18.2 Million Tonnes
Equipment and Supplies	3.289	5.874
Power and Lighting	.759	1.357
Space Heating	.375	.670
Dryer Fuel	2.915	5.201
Labour	.670	.893
TOTAL	8.008	13.995

Source: Letter from Simon-Carves of Canada Ltd. re "Capital and Operating Costs of Coal Preparation and Handling Plants", June 11, 1982 - Tables C and D.